CR 151029

RADAR BACKSCATTER PROPERTIES OF MILO AND SOYBEANS

Remote Sensing Laboratory
RSL Technical Report 177-59

T. F. Bush, F. T. Ulaby and T. Metzler
Principal Investigator: Fawwaz T. Ulaby

October, 1975

Supported by:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lyndon B. Johnson Space Center
Houston, Texas 77058

CONTRACT NAS 9-10261

THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

Milo and Soybeans

The second report, RSL TR 177-59, presents results for milo and soybeans of an experiment conducted by KU during 1974 to predict the applicability of radar to classification, maturity, and condition measurements of corn, wheat, alfalfa, milo, and soybeans; and the masking effects of these crops upon radar soil moisture response. A wide range of MAS 8-18 GHz instrument parameters were used during the experiment, which was conducted during the May through mid-September time period over typical fields in the Lawrence, Kansas, area.

The data indicated that maturity and condition measurements are not feasible for milo and soybeans due to the effects of soil moisture beneath the vegetation canopy which strongly influence the backscattered signal at low incidence angles and the small (1 to 3 dB) variations in backscattered signal at the higher angles as the crop matured. However, crop classification studies using the MAS field data for the five crops investigated produced classification accuracies of well above 95%, depending upon the instrument parameters used and observation intervals. The data is also valuable in indicating the masking effects of these crops for radar soil moisture measurements.

THE UNIVERSITY OF KANSAS SPACE TECHNOLOGY CENTER
Raymond Nichols Hall
CENTER FOR RESEARCH, INC.
2291 Irving Hill Drive—Campus West
Lawrence, Kansas 66045

Telephone: 913-864-4832

RADAR BACKSCATTER PROPERTIES OF MILO AND SOYBEANS

Remote Sensing Laboratory

RSL Technical Report 177-59

T. F. Bush, F. T. Ulaby and T. Metzler

Principal Investigator: Fawwaz T. Ulaby

October, 1975

Supported by:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Lyndon B. Johnson Space Center
Houston, Texas 77058

CONTRACT NAS 9-10261

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

ABSTRACT

The radar backscatter from fields of milo and soybeans was measured with a ground based radar as a function of frequency (8-18 GHz), polarization (HH and VV) and angle of incidence (0°-70°) during the summer of 1974. Supporting ground truth was gathered contemporaneously with the backscatter data. At nadir σ° of milo correlated highly, $r = 0.96$, with soil moisture in the milo field at 8.6 GHz but decreased to a value of $r = 0.78$ at a frequency of 17.0 GHz. Correlation studies of the variations of σ° with soil moisture in the soybean fields were not possible due to a lack of a meaningful soil moisture dynamic range. At the larger angles of incidence, however, σ° of soybeans did appear to be dependent on precipitation. It is suggested this phenomenon was caused by the rain altering plant geometry. In general σ° of both milo and soybeans had a relatively small dynamic range at the higher angles of incidence and showed no significant dependence on the measured crop parameters.

1.0 INTRODUCTION

During the summer months of 1974 an experiment was performed to determine the relationships between the radar scattering coefficient, σ^o, of five crop types and the physical characteristics of these crops. The crops studied were corn, alfalfa, wheat, milo and soybeans. The intent was to test the feasibility of monitoring the growth of these crops with radar. By functionally relating σ^o to certain crop development descriptors it was determined that it is possible to monitor the growth of wheat [1], alfalfa [2], and corn [3]. However, an analysis of the data collected from fields of milo and soybeans indicates that effective radar monitoring of these crops may not be possible. For the sake of completeness however, the results of the experiment pertaining to the milo and soybean fields will be summarized in this report.

2.0 GROUND TRUTH DATA AND ACQUISITION PROCEDURE

The ground truth data acquisition procedure has been discussed by Cihlar [4] and will not be reiterated in this report. The ground data collected were:

(a) Soil moisture on a volumetric basis, m_s (g/cm^3). (Six samples were collected at the field points described by Cihlar. Due to skin depth considerations [5] only the moisture in the top 2 cm was used in the data analysis).

(b) Plant moisture on a gravimetric basis, m_p (g/g i.e. mass of water per mass of wet plant matter).

(c) Plant canopy height, h (m).

(d) Precipitation as measured at the Lawrence, Kansas weather observation station. (Note that the data were collected near Eudora, Kansas, approximately 12 km East of Lawrence).

Figures 1 and 2 present the variations of these field variables as a function of time as collected from the soybean and milo fields respectively. Each figure clearly depicts the variations in plant height. For soybeans the net change in plant height was 1.04

meters while for milo a 0.87 meter net height change was recorded. It should be noted that while the soil moisture, m_s, in the milo field showed large fluctuations as a function of time, the soil moisture in the soybean field remained extremely low until August 2 at which point the soybean canopy was 0.84 meters tall. This point is important in that the lack of a wide range of soil moisture data severely restricted an analysis of the effects of moisture in the soil underlying the soybeans on σ^o. Appendicies A and B contain the measured ground truth data for soybeans and milo, respectively, in a tabular form.

3.0 RADAR DATA ACQUISITION PROCEDURE

Scattering data were acquired with the University of Kansas Remote Sensing Laboratory Microwave Active Spectrometer, 8-18 GHz (MAS 8-18). A detailed description of its operational characteristics has been reported [6] and these characteristics will not be presented herein although a summary of the MAS 8-18 characteristics is available in Table I. To reduce the effects of fading on the precision of the scattering data both frequency and spatial averaging techniques were employed [7]. Ninety percent confidence interval estimates for σ^o vary between (+ 1.8 dB, -2.0 dB) at nadir and (+0.403 dB, -0.403 dB) at an angle of incidence (measured from nadir) of 70°.

4.0 TEMPORAL VARIATIONS OF σ^o

This section presents typical temporal data records of σ^o for both crop types under discussion. Data are plotted for various frequency-polarization-angle of incidence combinations. Appendicies C and D present, in a tabular fashion, all of the scattering data from the soybean and milo fields respectively.

4.1 Temporal Variations of σ^o of Soybeans

Figures 3a-b present $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ as measured at nadir at 8.6 and 17.0 GHz. At 8.6 GHz, $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ (Figure 3a) shows a 9.4 dB and 12.7 dB dynamic range respectively. Neither $\overline{\sigma_H^o}$ nor $\overline{\sigma_V^o}$, however, significantly correlate with any of the measured ground truth data. This is true not only at 8.6 GHz but also at 13.0 and 17.0 GHz (e.g., Figure 3b). It is expected if the moisture in the underlying soil had shown more extreme variations while the soybean canopy was relatively short, σ^o would show a significant correlation with soil moisture.

Figures 4a-b present the data record of $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ as measured at an angle of incidence of 30°. At 8.6 GHz (Figure 4a) both $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ show a definite trend to increase with time. In fact a simple linear regression of σ^o on time results in an estimated correlation of $r_H = 0.819$ and $r_V = 0.879$ for the horizontally and vertically polarized data. Furthermore by regressing σ^o on plant height (in meters), estimated correlation coefficients of $\overline{\sigma_H} = 0.814$ and $r_V = 0.870$ were obtained. However, the slopes of the regression lines (in dB/meter) were only 2.2 dB/meter (2.8 dB/meter) for the horizontal (vertical) data. Thus, while at 8.6 GHz, 30°, σ^o shows a dependence on plant height, the sensitivity of σ^o to plant height variations is quite small. As frequency is increased (Figure 4b), the linear trend in σ^o which was apparent at 8.6 GHz has disappeared. The reduction in this trend is attributed to rainfall. Consider the 17.0 GHz data collected at an angle of incidence of 30°. On August 6 and August 22 a dip is discernible in the trend of σ^o. By referring to Figure 1 it is seen that on both dates a significant amount of rain fell. This rain was recorded in the early morning hours and did not result in a wet crop when data were collected with the radar. It is felt however that the effect of these rains was to alter the plant canopy geometry in such a manner so as to reduce the value of σ^o. This phenomenon has also been noted for σ^o of corn fields [8]. For the case of corn this trend for σ^o to decrease following a rain was more marked as both frequency and the angle of incidence increased. Again this is the case for soybeans as can be seen in Figures 5 and 6.

Figures 5 and 6 present σ^o as a function of time as measured at angles of incidence of 50° and 70° respectively. Note that not only do $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ show a marked dip on August 6 and 22 but also on August 2. From Figure 1 it is seen that while no rain was recorded in Lawrence on or shortly before August 2, the measured soil moisture showed that indeed it had rained at the observation site shortly before the August 2 data were collected. Furthermore it should be noted that the effect of the rain increases with both frequency and the angle of incidence.

4.2 Temporal Variations of σ^o of Milo

Figures 7 through 10 present the temporal variations of $\overline{\sigma_H^o}$ and $\overline{\sigma_V^o}$ of milo at four angles of incidence at 8.6 and 17.0 GHz. If we compare the soil moisture history as shown in Figure 2 to the σ^o history as measured at 8.6 GHz at nadir (Figure 7a) it is apparent that soil moisture had a significant influence on σ^o as measured at nadir.

The estimated linear correlation coefficient between σ_H^o (σ_V^o) and soil moisture is 0.920 (0.956). If however we increase frequency to 13.0 GHz the dependence of σ_H^o and σ_V^o on soil moisture appears to have lessened. This is reflected in the values of the estimated correlation coefficients of the horizontally and vertically polarized data which are 0.710 and 0.762 respectively. Finally at 17.0 GHz (Figure 7b) the correlation coefficients are 0.626 and 0.784. It is felt that the trend for the dependence of σ^o (as measured at nadir) on soil moisture to decrease with increasing frequency is the result of increasing attenuation, which increases with frequency, caused by the milo canopy.

Figures 8 through 10 present the temporal variations of σ^o at the higher angles of incidence and at the higher frequencies. The lack of any meaningful dynamic range at these angles and frequencies is one indication that it is quite difficult to develop any significant functional relationship between σ^o and any of the crop development descriptors. Efforts were made, however, to develop such relationships with little success being achieved.

5.0 ANGULAR VARIATIONS OF σ^o OF SOYBEANS AND MILO

This section will briefly present the angular response characteristics of soybeans and milo as measured during 1974. The response as measured on three dates will be presented for each crop type along with a short comparison of these data with data collected in 1973 [8].

5.1 Angular Variation of σ^o of Soybeans

Figures 11 and 12 present the angular variations of σ_H^o and σ_V^o of soybeans at 8.6 and 17.0 GHz. From these figures it is again apparent that σ^o shows little response to temporal changes at the higher angles of incidence. It is interesting to note, however, that σ^o as measured in the 60°-70° range is rather low. In Figure 11a for example σ_H^o between -16 and -19 dB at 8.6 GHz at 70°. It is also notable that at 8.6 GHz, σ_H^o as measured at nadir on July 24 is about 8 dB higher than the remaining two values of σ_H^o. Since the soil moisture was quite low on July 24 as compared with that as measured on either June 27 or on August 22 it seems that the variations in σ^o at nadir are significantly influenced by factors other than soil moisture. These factors are probably the macro- and micro-geometry of the plant canopy.

The same effect at nadir is also evident at higher frequencies (Figures 12a and 12b) although the curves of σ^o versus the angle of incidence assume rather different characteristics from those at 8.6 GHz. This is certainly expected, however, since the canopy geometry, which is described in terms of the signal wavelength, will vary with signal frequency.

Figures 13 and 14 compare data collected in 1973 [8] and 1974. These two sets were chosen to provide a mid-range value of canopy height and because of the very similar characteristics of the two crops. The agreement between the 1973 and 1974 data is good, particularly at angles of incidence in the 10^o through 60^o range although σ_V^o at 17.0 GHz shows disparity in the 30^o through 60^o range.

5.2 Angular Variations of σ^o of Milo

Figures 15 and 16 present the measured angular variations of σ_H^o and σ_V^o of milo as measured in 1974. Data are depicted as measured on three different dates during the growing season. In contrast to the angular response of σ^o of soybeans, the σ^o versus angle curves show a trend toward convexity, particularly at the higher angles of incidence and at the higher frequencies. In fact it is interesting to note that the trends of σ^o at 17.0 GHz are nearly Lambertian in nature.

Figures 17 and 18 compare data collected in 1973 [8] and 1974 from two milo fields. While the absolute agreement of these data is not quite as good as that of soybeans, the trends in the response of σ^o are certainly comparable in the 10^o through 70^o range of incidence angles.

6.0 CONCLUDING REMARKS

1. Because of a lack of wide range of soil moisture data when the soybean canopy was immature it was not possible to determine the ability of the MAS 8-18 to penetrate a soybean canopy. It was determined, however, that it is possible to penetrate a milo canopy with X-band signals and to make certain inferences as to the amount of moisture in the underlying soil.

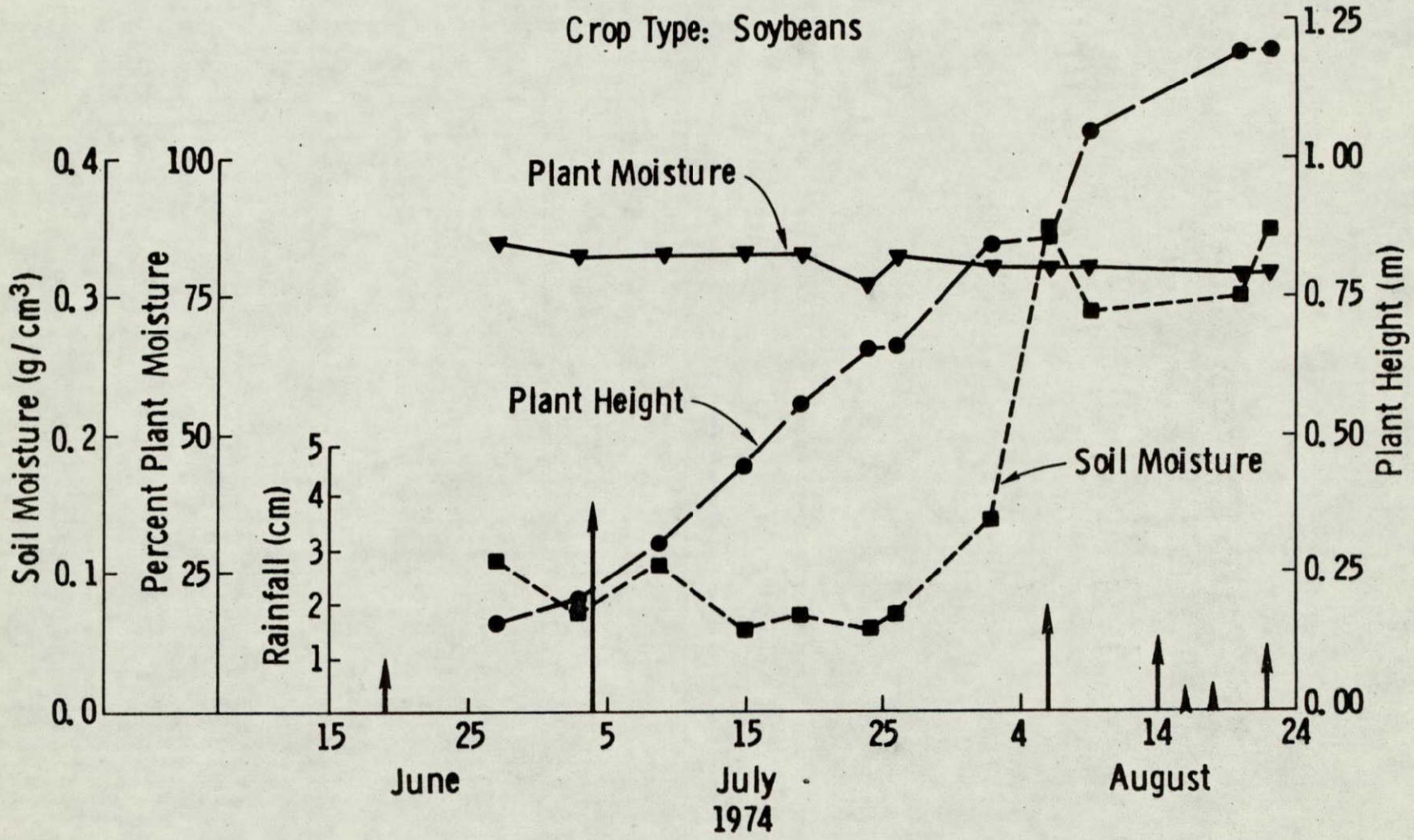


Figure 1. Data record of plant moisture, soil moisture, and plant height as collected from the soybean field.

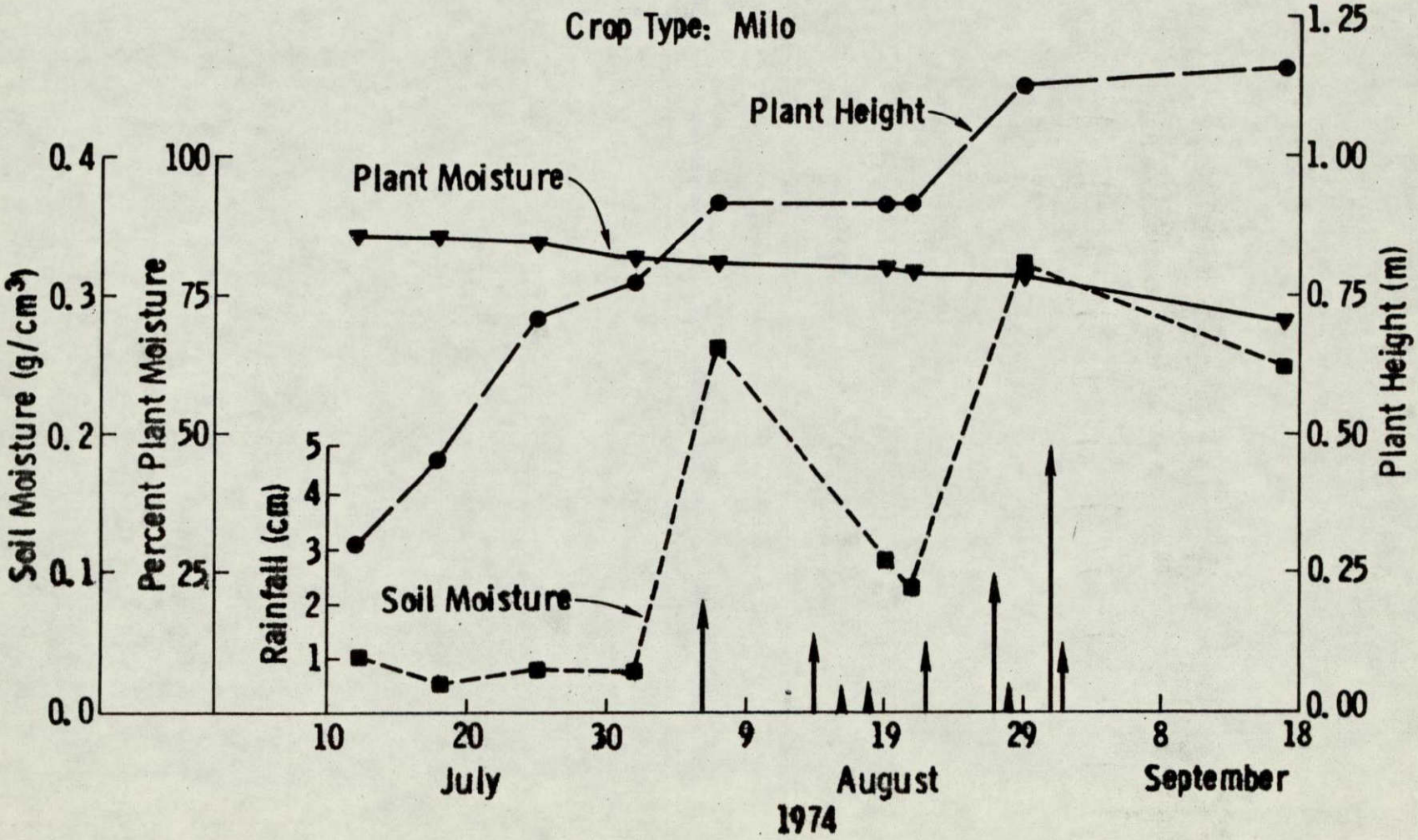
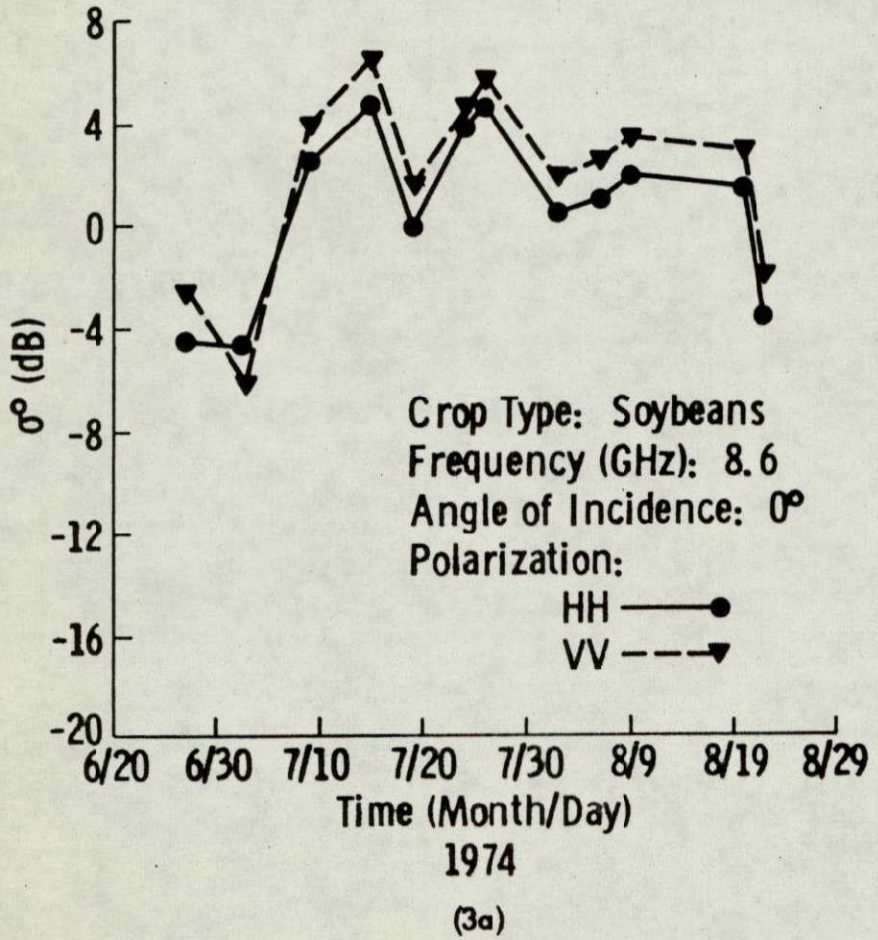
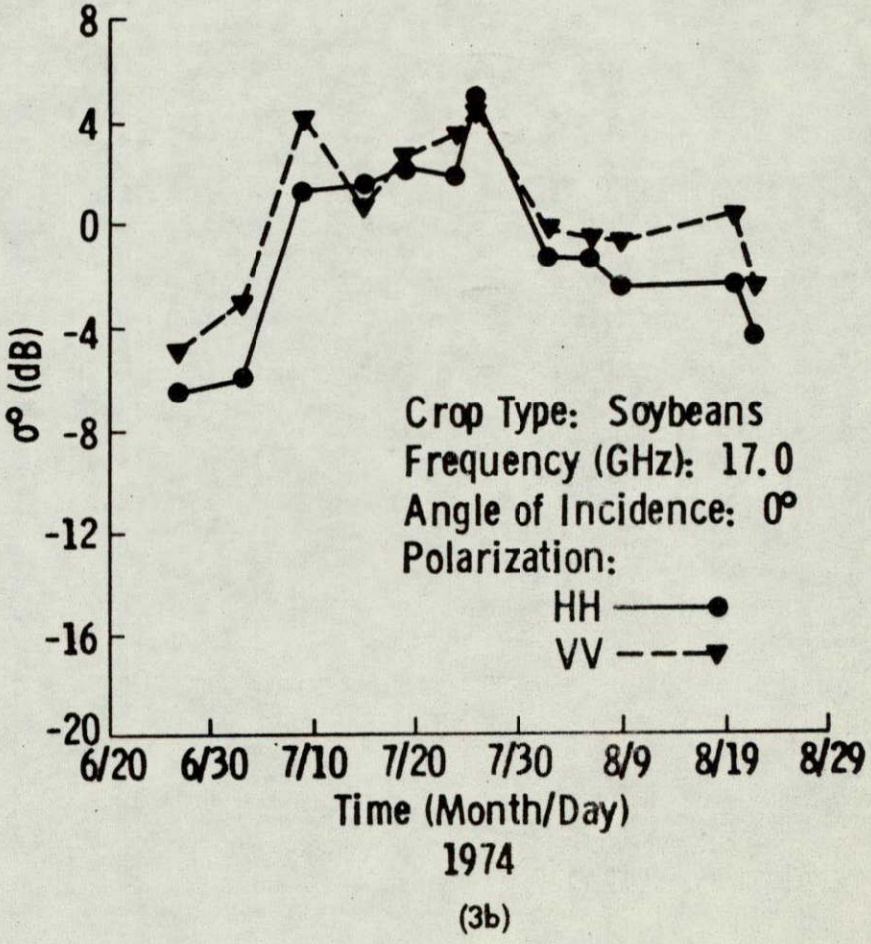


Figure 2. Data record of plant moisture, soil moisture, and plant height as collected from the milo field.

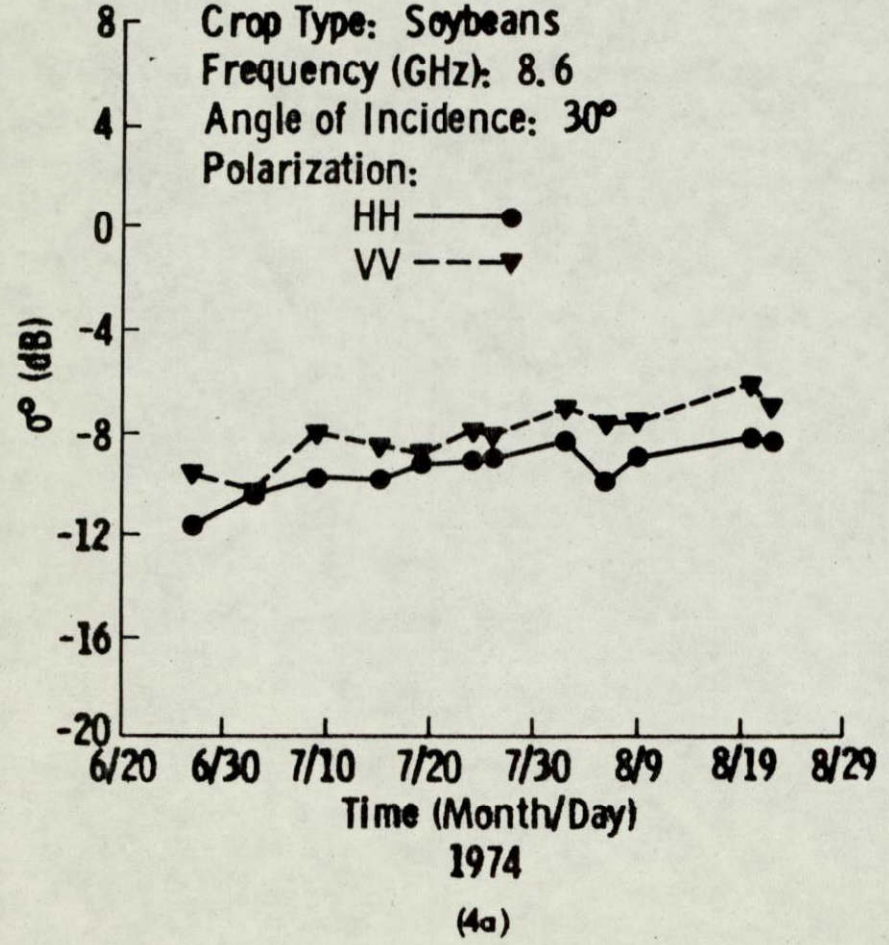


(3a)

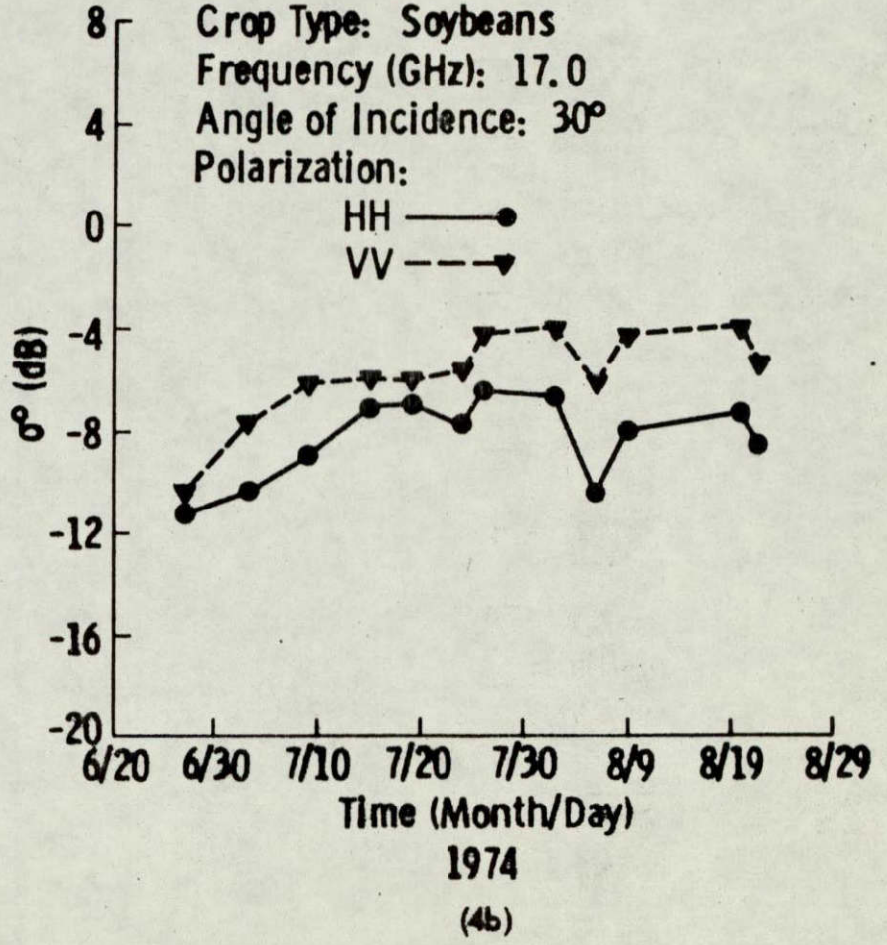


(3b)

Figure 3. Time history of σ° of soybeans as measured at 0° at frequencies of 8.6 GHz (3a) and 17.0 GHz (3b).

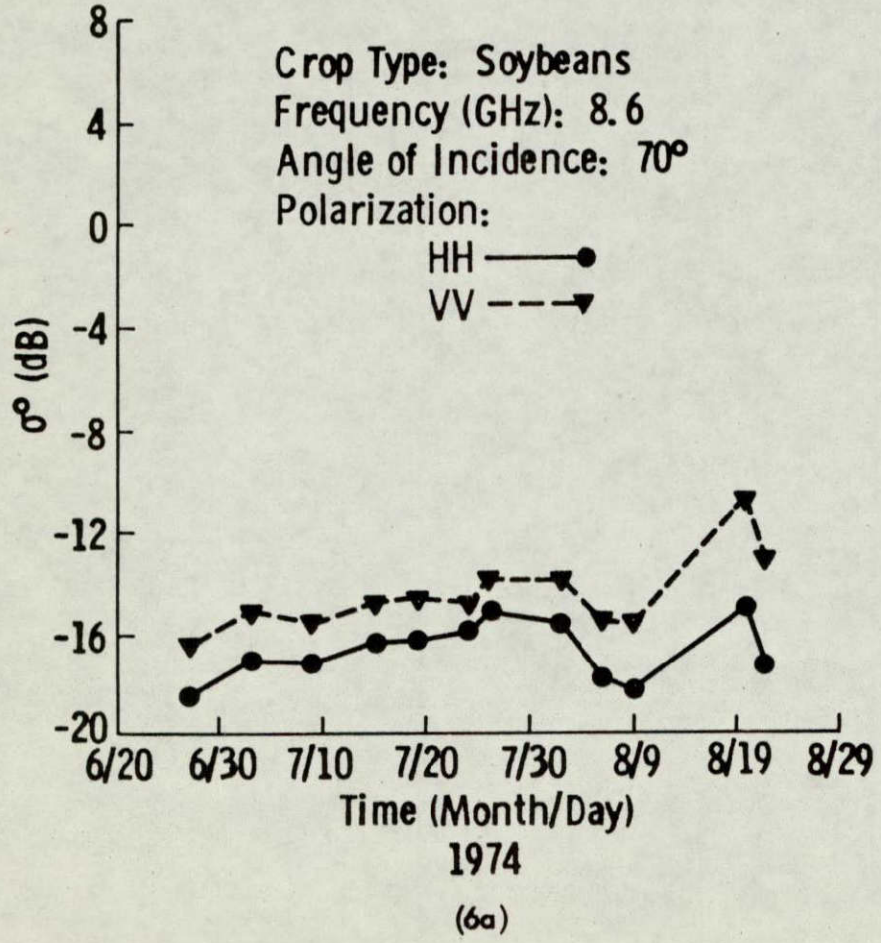


(4a)

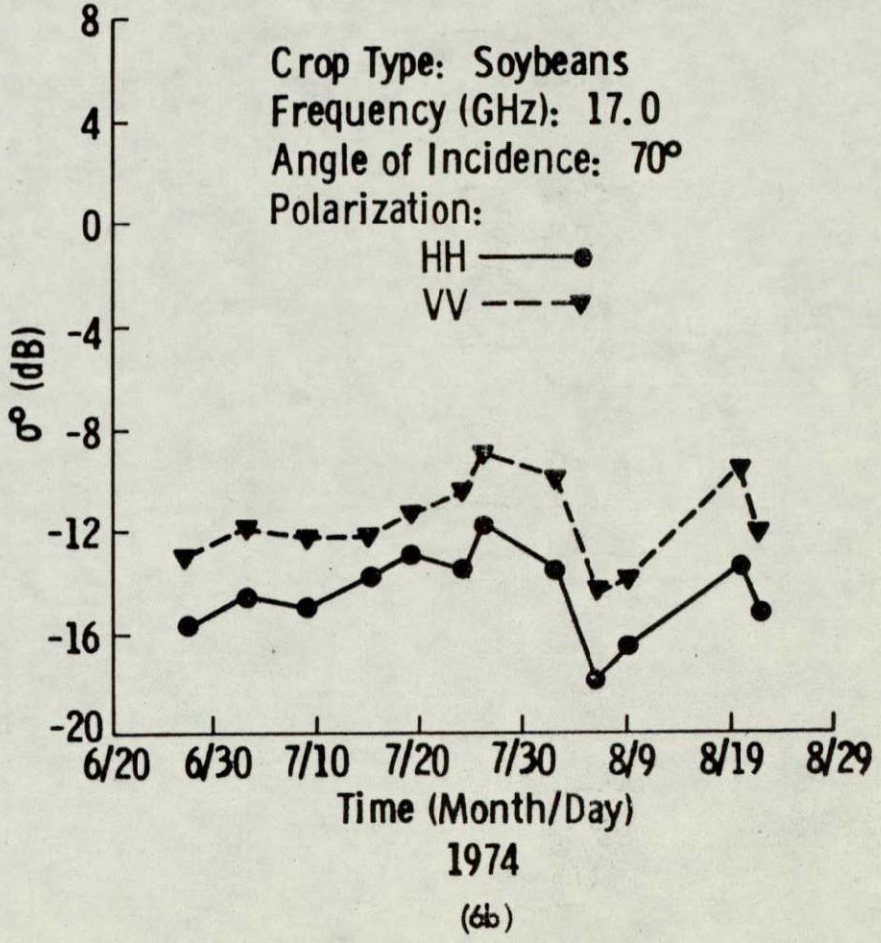


(4b)

Figure 4. Time history of σ° of soybeans as measured at 30° at frequencies of 8.6 GHz (4a) and 17.0 GHz (4b).

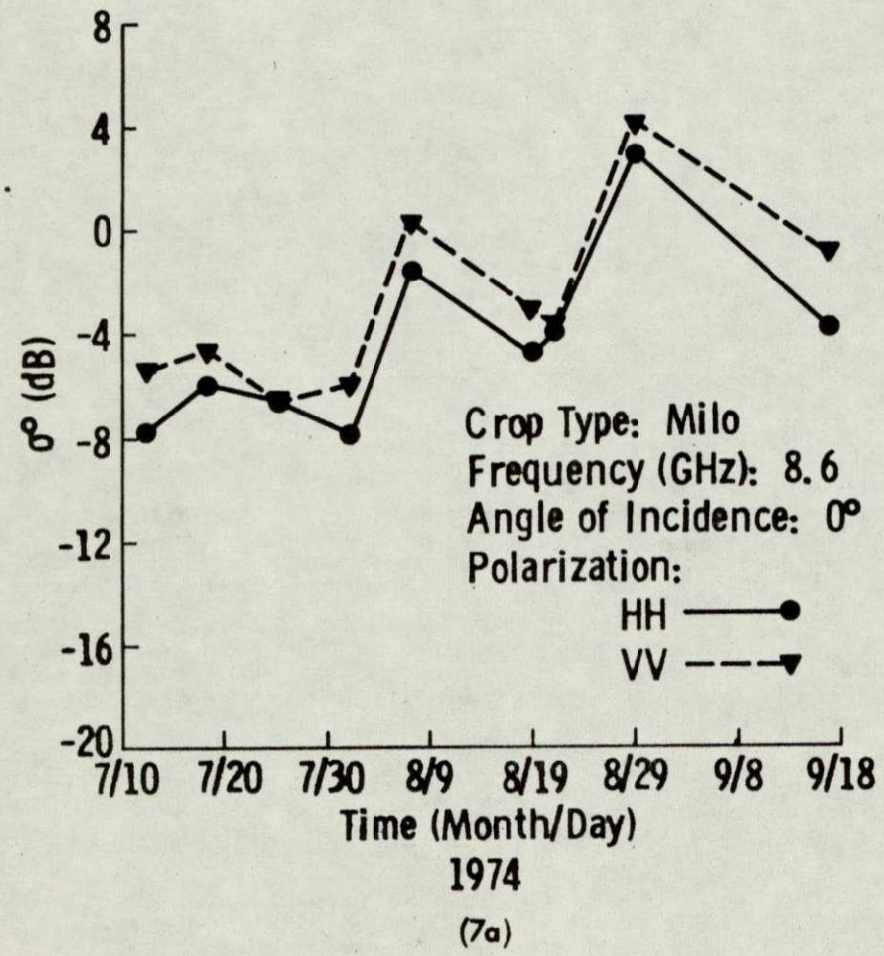


(6a)

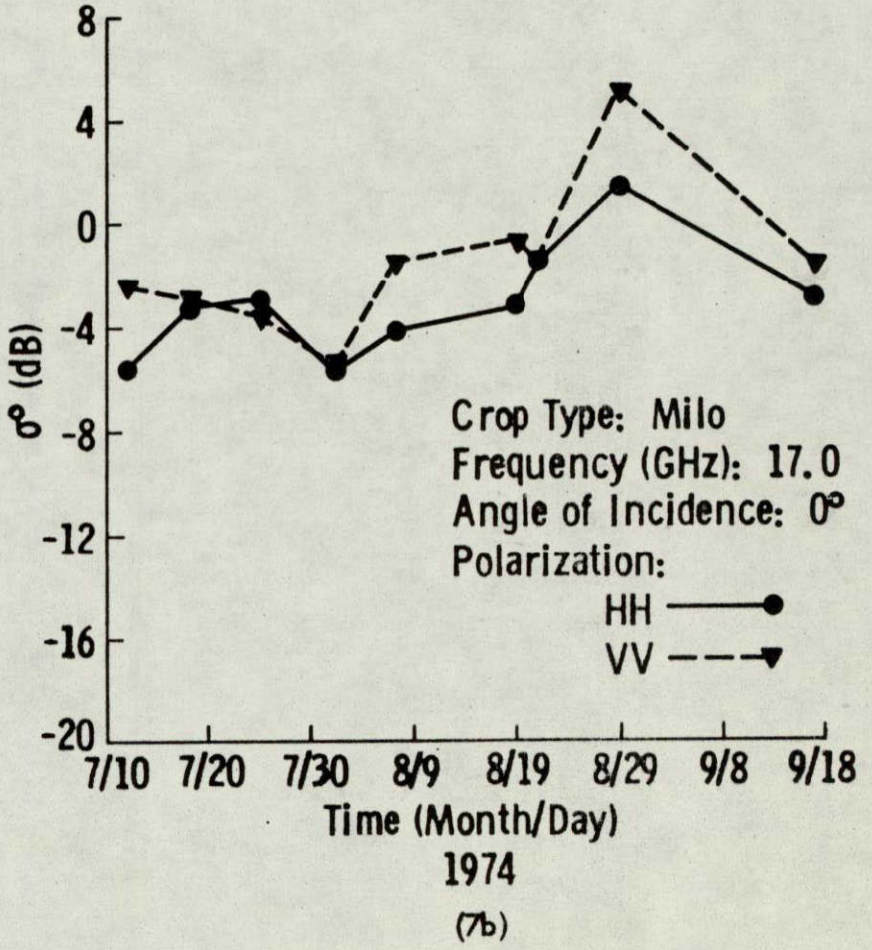


(6b)

Figure 6. Time history of σ° of soybeans as measured at 70° at frequencies of 8.6 GHz (6a) and 17.0 GHz (6b).



(7a)



(7b)

Figure 7. Time history of σ° of milo as measured at 0° at frequencies of 8.6 GHz (7a) and 17.0 GHz (7b).

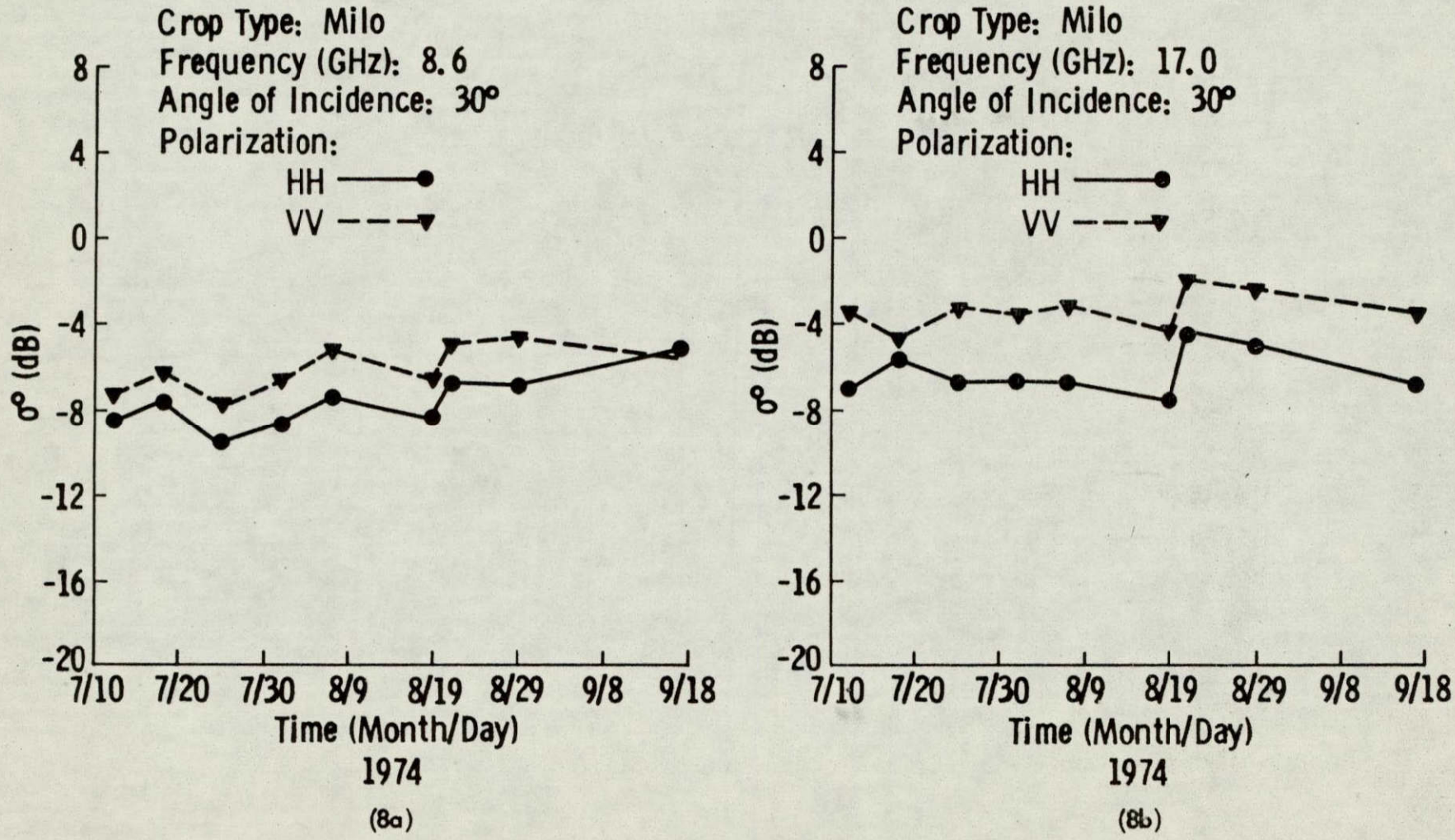
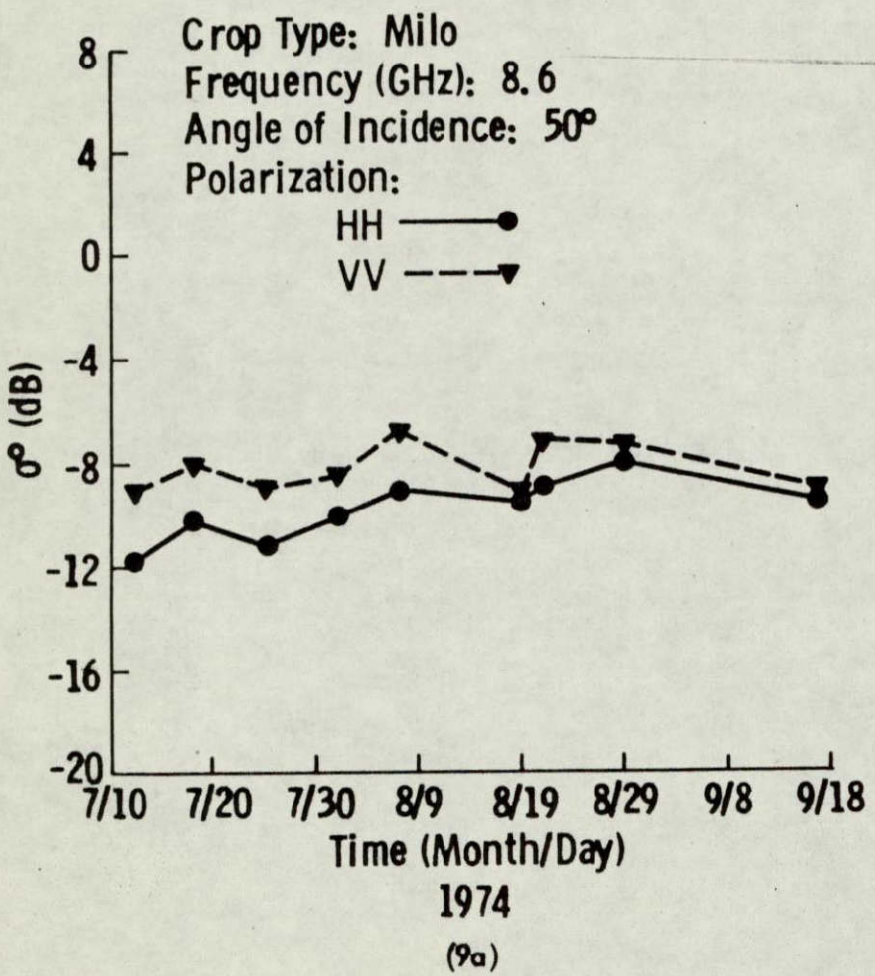
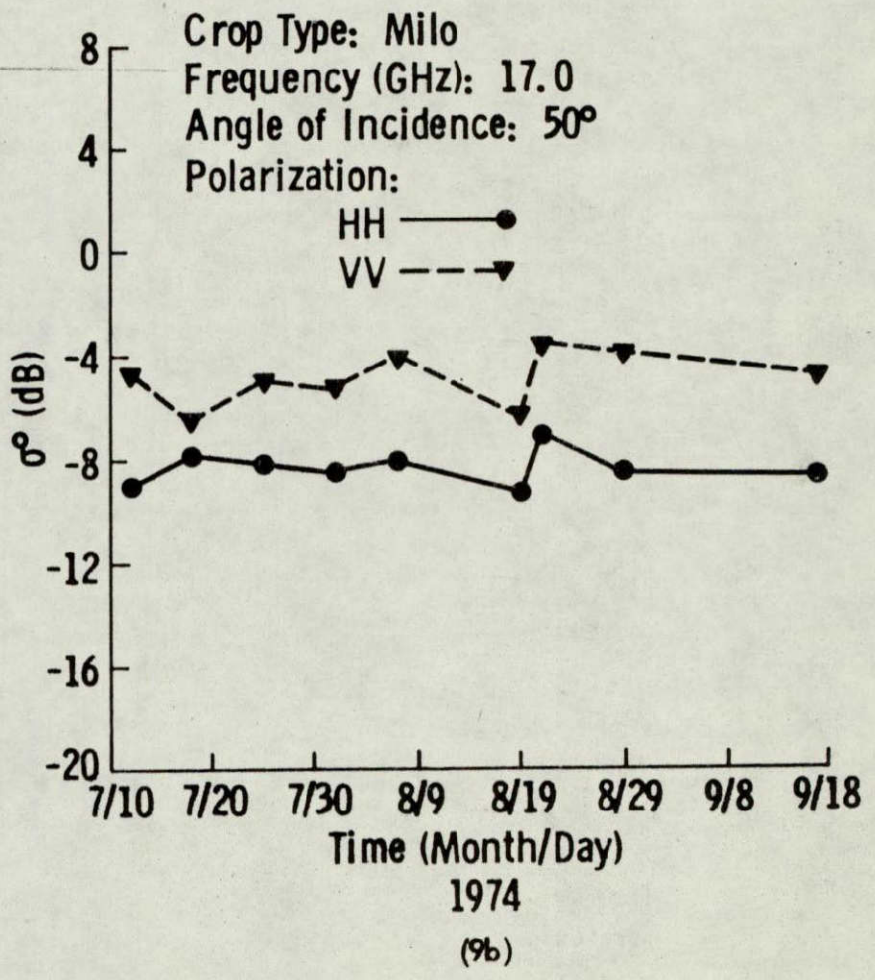


Figure 8. Time history of σ° of milo as measured at 30° at frequencies of 8.6 GHz (8a) and 17.0 GHz (8b).



(9a)



(9b)

Figure 9. Time history of σ° of milo as measured at 50° at frequencies of 8.6 GHz (9a) and 17.0 GHz (9b).

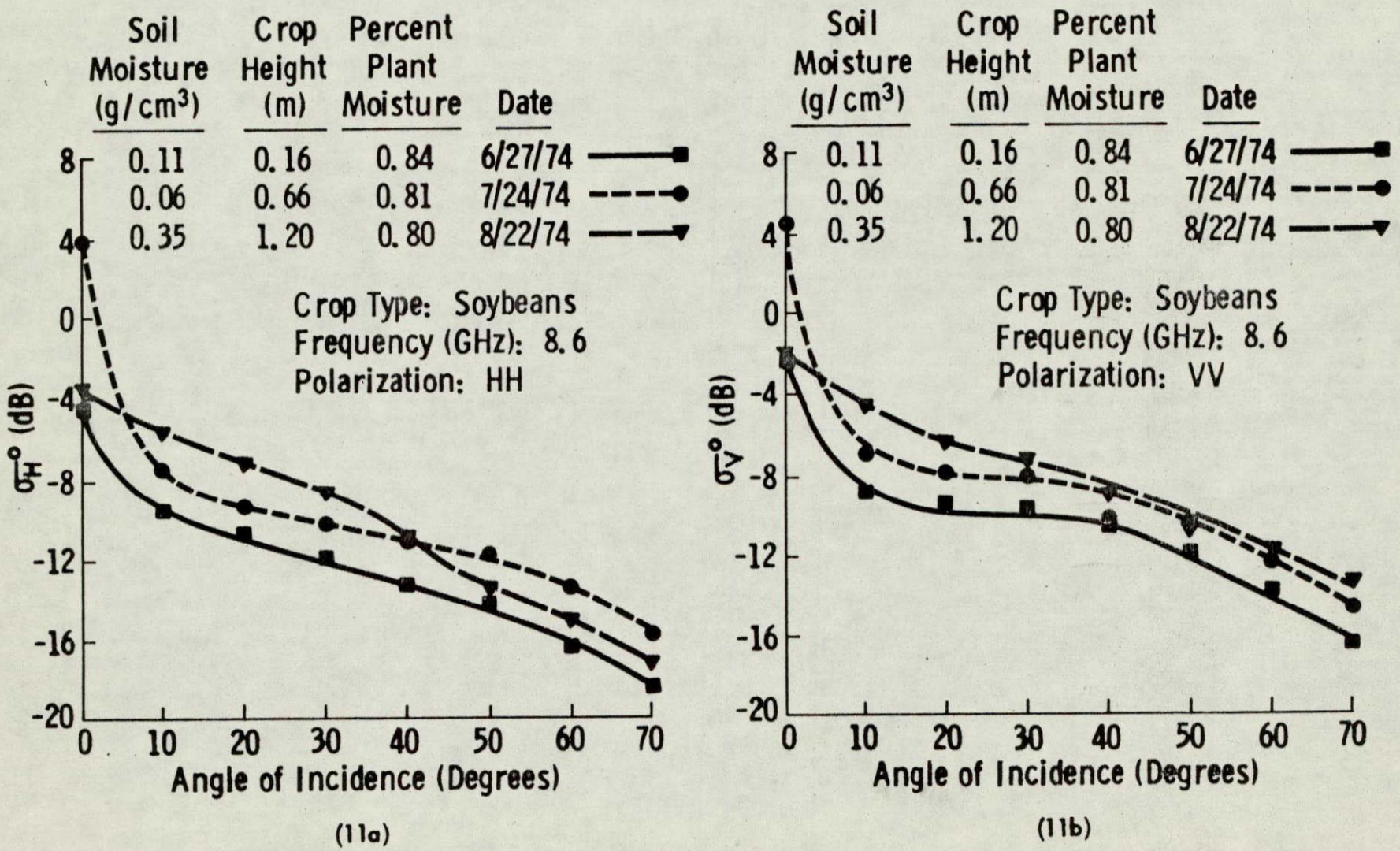


Figure 11. Angular response of σ_H° (11a) and σ_V° (11b) of soybeans as measured at 8.6 GHz. Three curves are presented representing different crop conditions which are noted in the figure.

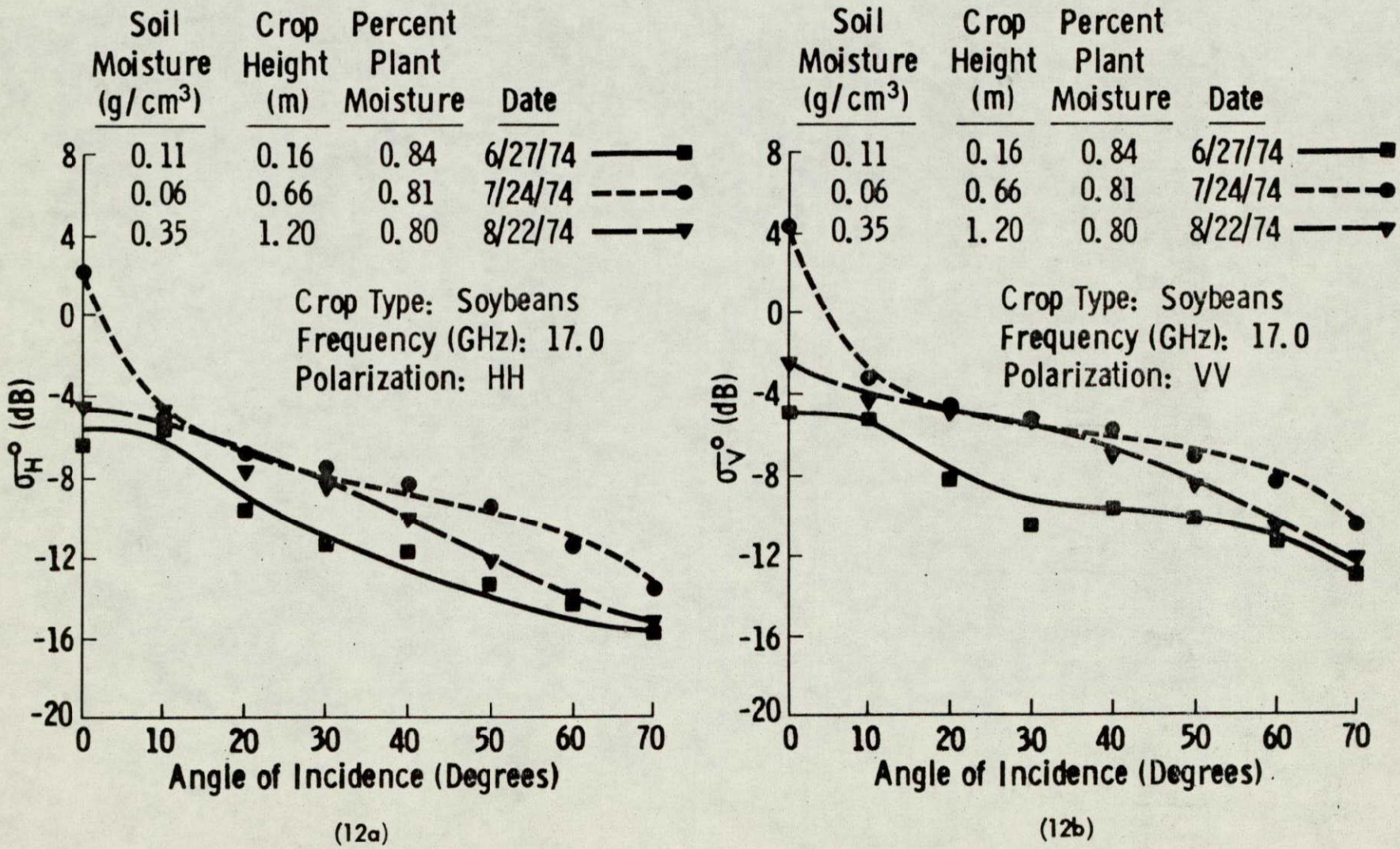


Figure 12. Angular response of σ_H° (12a) and σ_V° (12b) of soybeans as measured at 17.0 GHz. Three curves are presented representing different crop conditions which are noted in the figure.

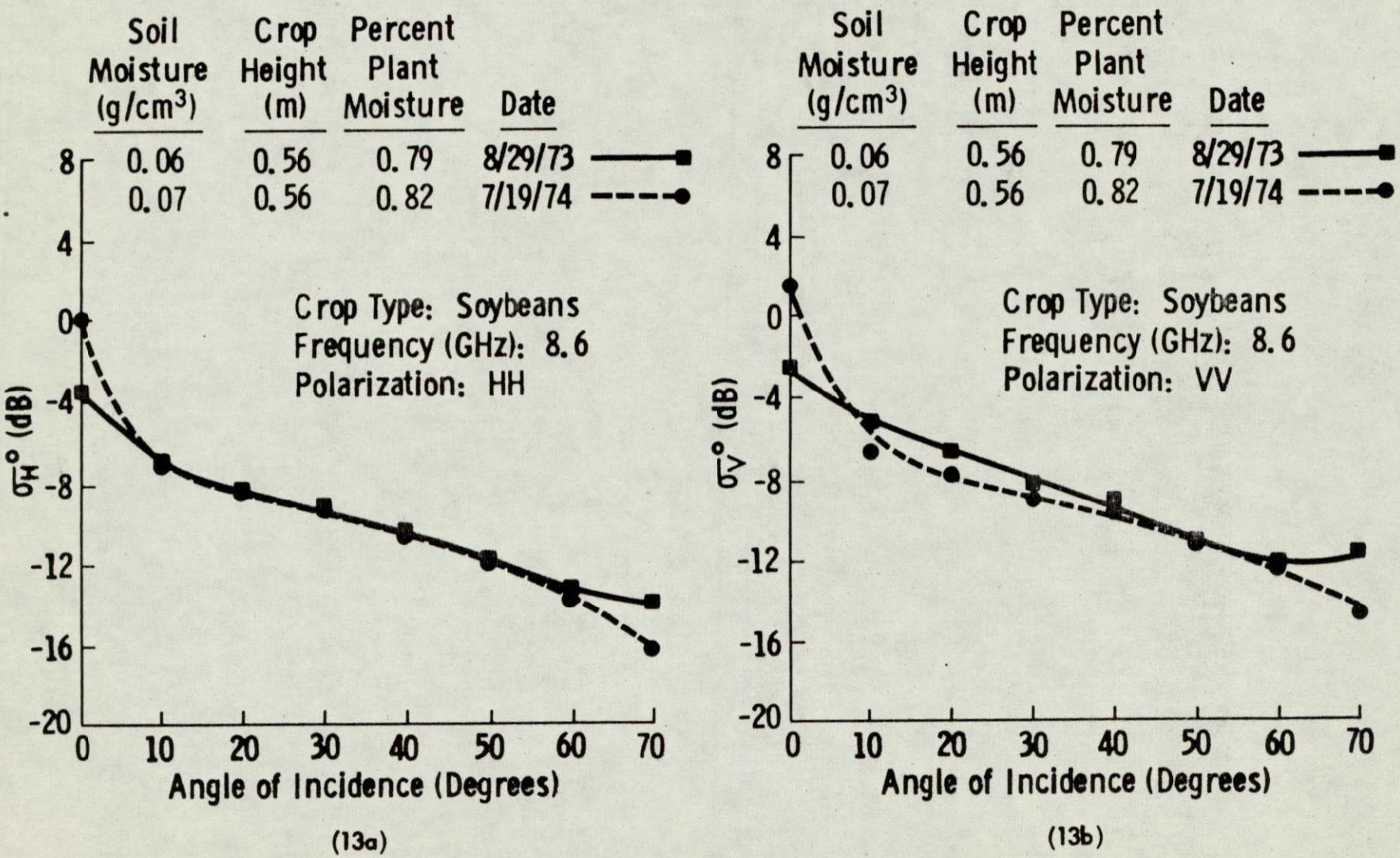
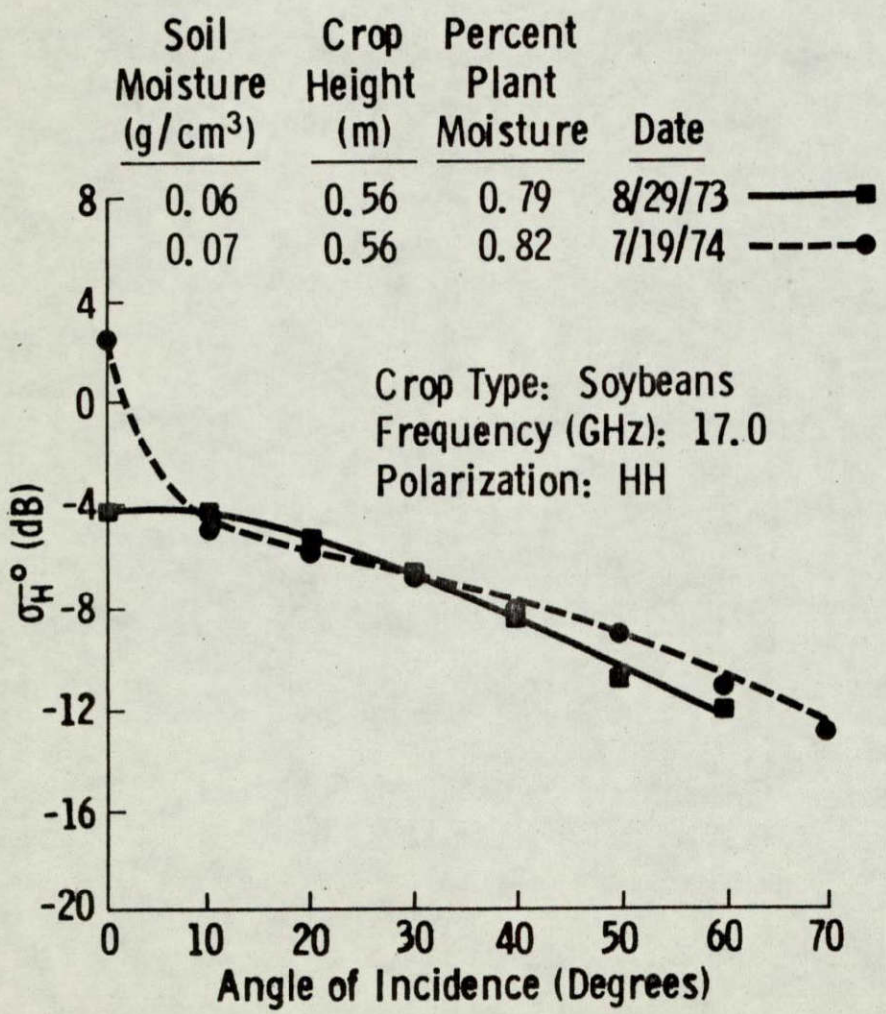
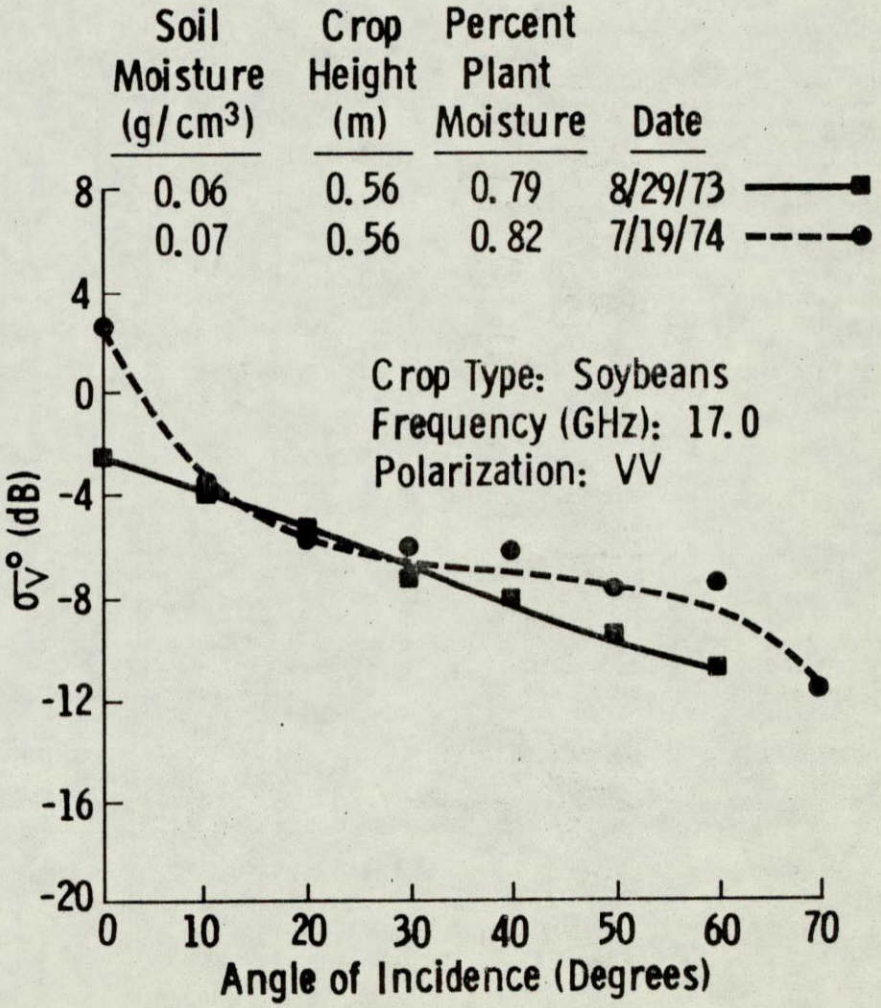


Figure 13. Angular response of σ_H° (13a) and σ_V° (13b) as measured in 1973 and 1974 at 8.6 GHz. These data were chosen for comparison based on field condition similarities.



(14a)



(14b)

Figure 14. Angular response of σ_H° (14a) and σ_V° (14b) as measured in 1973 and 1974 at 17.0 GHz. These data were chosen for comparison based on field condition similarities.

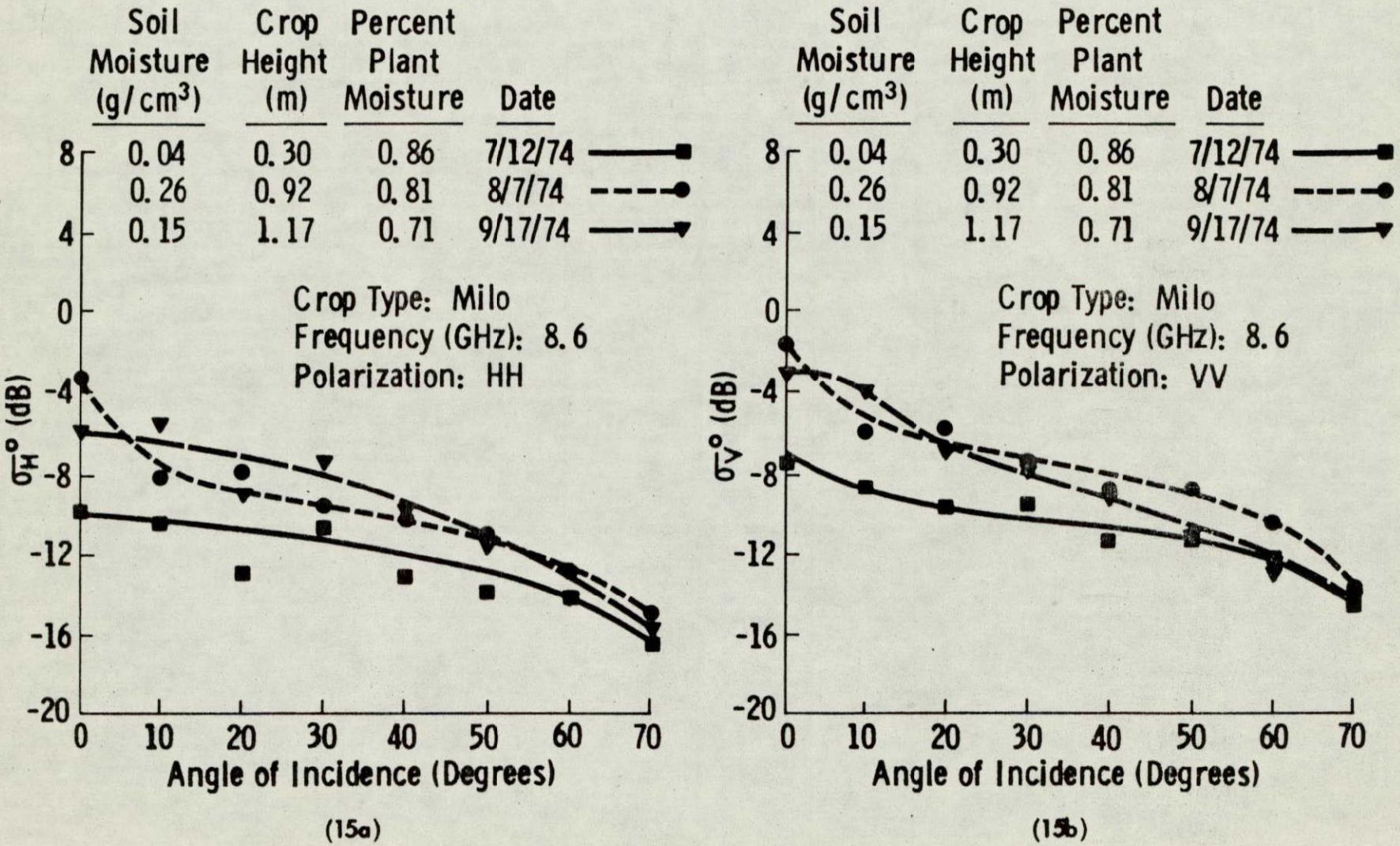


Figure 15. Angular response of σ_H° (15a) and σ_V° (15b) of milo as measured at 8.6 GHz. Three curves are presented representing different crop conditions which are noted in the figure.

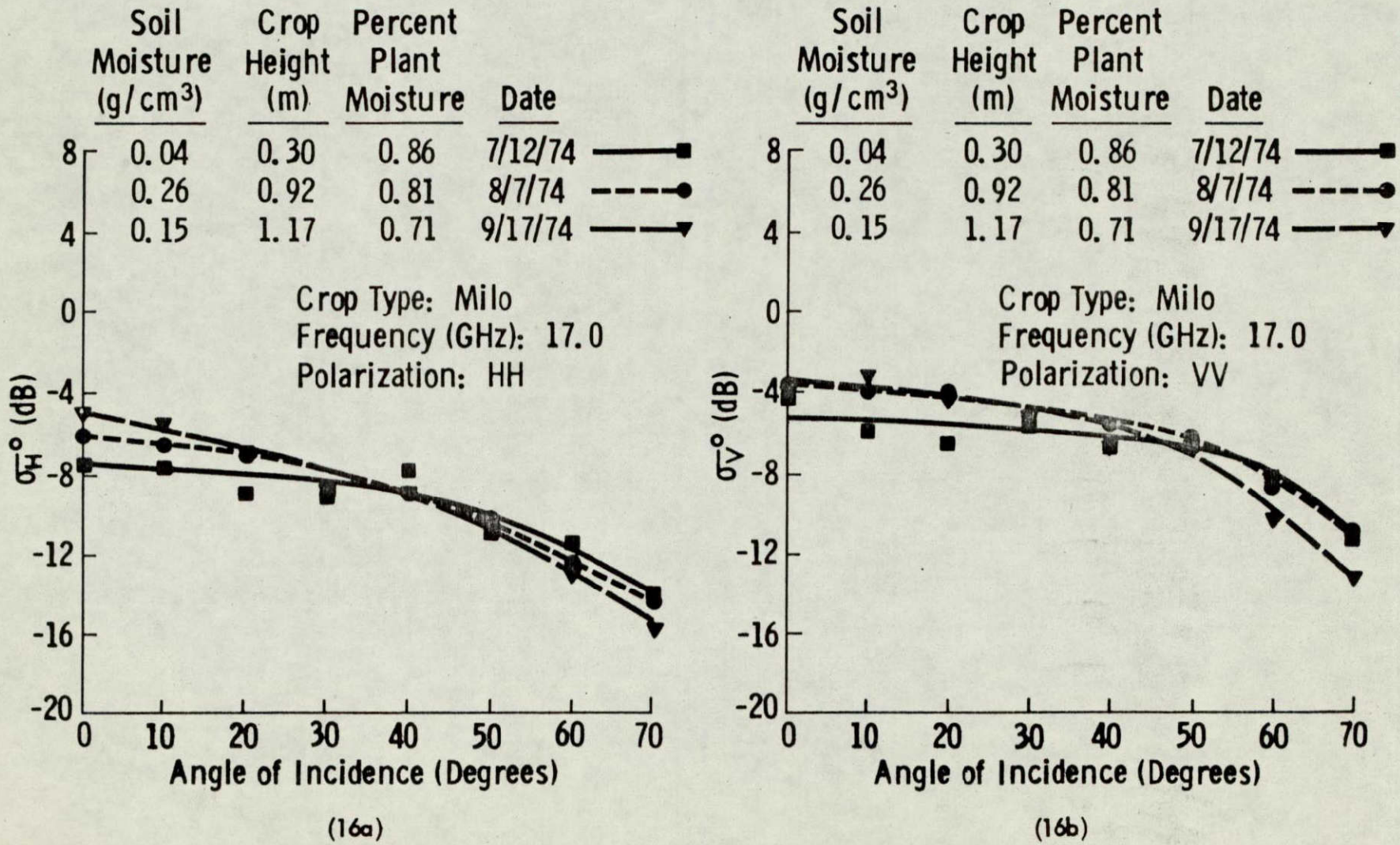


Figure 16. Angular response of σ_H° (16a) and σ_V° (16b) of milo as measured at 17.0 GHz. Three curves are presented representing different crop conditions which are noted in the figure.

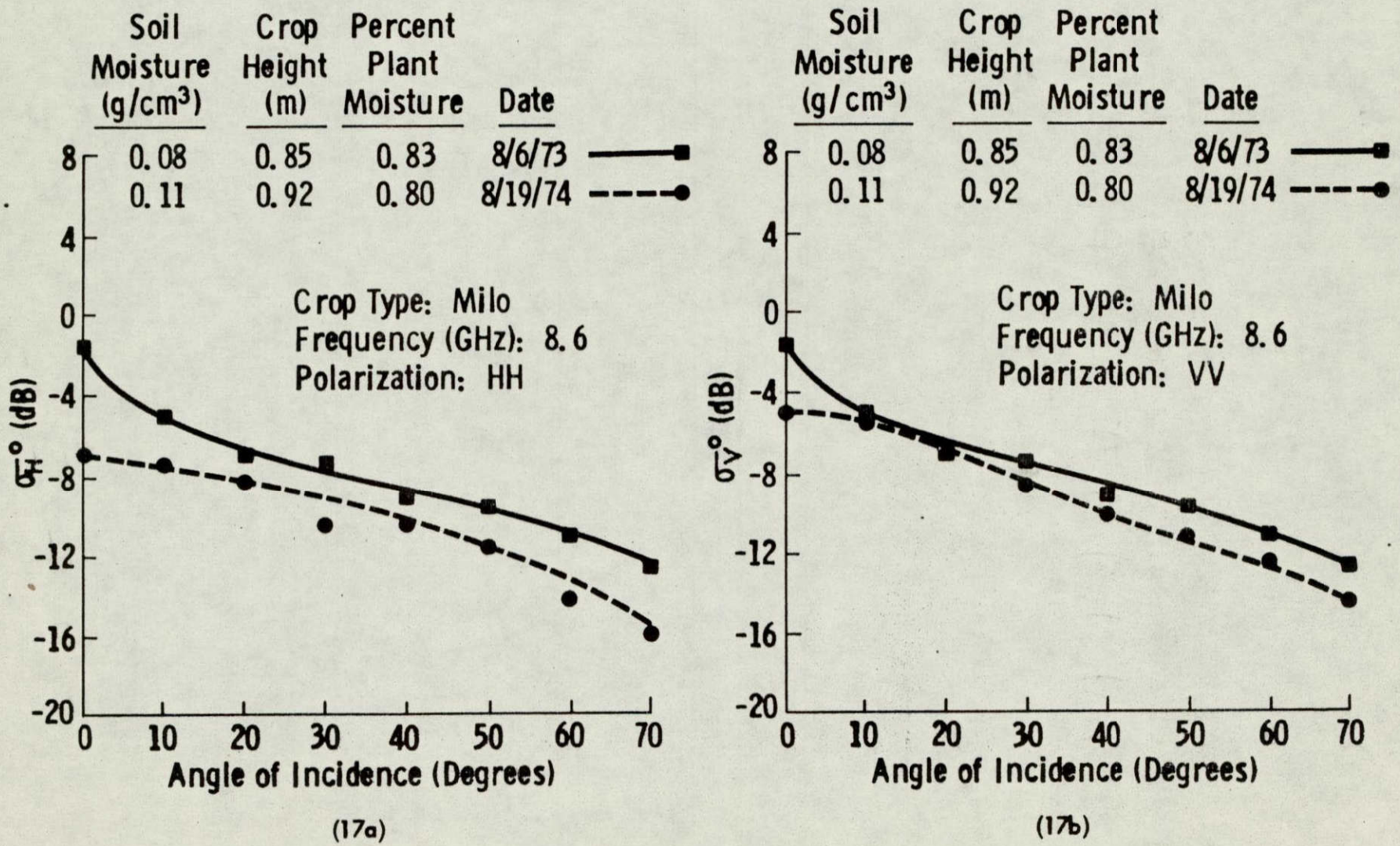


Figure 17. Angular response of σ_H° (17a) and σ_V° (17b) as measured in 1973 and 1974 at 8.6 GHz. These data were chosen for comparison based on field condition similarities.

REFERENCES

[1] Ulaby, F. T. and T. F. Bush, "Monitoring Wheat Growth with Radar," Photogrammetric Engineering and Remote Sensing, v. 42, n. 4, pp. 557-568, April, 1976.

[2] Bush, T. F. and F. T. Ulaby, "Radar Return from a Continuous Vegetation Canopy," IEEE Trans. on Antennas and Propagation, v. AP-24, n. 3, pp. 269-276, May, 1976.

[3] Ulaby, F. T. and T. F. Bush, "Corn Growth as Monitored by Radar," IEEE Trans. on Antennas and Propagation, November, 1976 issue.

[4] Cihlar, J., "Ground Data Acquisition Procedure for Microwave (MAPS) Measurements," RSL Technical Memorandum 177-42, University of Kansas Center for Research, Inc., Lawrence, Kansas, July, 1973.

[5] Cihlar, J. and F. T. Ulaby, "Dielectric Properties of Soils as a Function of Moisture Content," RSL Technical Report 177-47, University of Kansas Center for Research, Inc., Lawrence, Kansas, November, 1974.

[6] Bush, T. F. and F. T. Ulaby, "8-18 GHz Radar Spectrometer," RSL Technical Report 177-43, University of Kansas Center for Research, Inc., Lawrence, Kansas, September, 1973.

[7] Bush, T. F. and F. T. Ulaby, "Fading Characteristics of Radar Backscatter from Selected Agricultural Targets," IEEE Trans. on Geoscience Electronics, v. GE-13, n. 4, pp. 149-157, October, 1975.

[8] Ulaby, F. T., T. F. Bush and P. P. Batlivala, "Radar Response to Vegetation II: 8-18 GHz Band," IEEE Trans. on Antennas and Propagation, v. AP-23, n. 5, pp. 608-618, September, 1975.

APPENDIX A: Ground Truth Summary for 1974 Soybeans Scattering Experiment.

SOYBEANS GROUND TRUTH 1974

Date	Soil Moisture (g/cm^3) N	M	F	% Plant Moisture	Plant Height (m)
June 27	.11	.11	.09	84	16
July 3	.08	.07	.09	82	21
July 9	.11	.11	.10	82	31
July 15	.07	.06	.05	82	44
July 19	.06	.07	.06	82	56
July 24	.06	.06	.06	81	66
July 26	.05	.07	.07	82	66
August 2	.09	.14	.14	81	84
August 6	.33	.35	.33	81	86
August 9	.22	.29	.28	81	105
August 20	.31	.30	.29	79	120
August 22	.34	.35	.34	80	120

N = near range sample M = medium range sample F = far range sample

APPENDIX B: Ground Truth Summary for 1974 Milo Scattering Experiment.

MILO GROUND TRUTH 1974

Date	Soil Moisture g/cm^3) N	M	F	% Plant Moisture	Plant Height (m)
July 12	.04	.04	.06	86	30
July 18	.02	.02	.03	86	46
July 25	.03	.03	.03	84	71
August 1	.03	.03	.03	82	77
August 7	.27	.26	.26	81	92
August 19	.13	.11	.12	80	92
August 21	.07	.09	.07	78	92
August 29	.30	.32	.31	78	112
September 17	.15	.15	.17	71	117

N = near range sample M = medium range sample F = far range sample

APPENDIX C: Soybeans Scattering Coefficients, 1974.

Averaged Sigmao Soybeans, June 27, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-4.5	-6.4	-6.2	-4.8	-2.1	-2.2	-3.1	-2.0	-0.9	-4.3	-6.5
POL VV	-2.4	-3.9	-2.5	-1.7	-1.2	-1.6	-1.5	0.6	0.4	-4.8	-5.0

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.6	-9.9	-8.9	-7.4	-8.7	-5.9	-6.5	-5.2	-4.0	-5.2	-5.6
POL VV	-8.8	-8.5	-7.8	-6.4	-7.2	-6.0	-4.5	-3.8	-3.2	-5.9	-5.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.6	-9.8	-9.9	-6.9	-7.2	-7.9	-10.9	-8.1	-5.5	-7.8	-9.6
POL VV	-9.4	-9.5	-7.7	-6.5	-6.6	-7.7	-6.2	-6.6	-6.8	-8.0	-8.2

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.8	-10.9	-10.5	-10.6	-9.0	-10.4	-10.2	-9.7	-8.1	-10.6	-11.3
POL VV	-9.7	-9.4	-8.6	-8.6	-7.5	-8.4	-7.1	-7.1	-7.7	-9.7	-10.5

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.3	-13.7	-11.4	-11.4	-10.4	-10.6	-11.7	-10.7	-10.0	-12.1	-11.7
POL VV	-10.7	-10.4	-9.9	-9.9	-8.6	-8.2	-7.2	-9.2	-8.2	-10.1	-9.8

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.2	-14.5	-13.3	-12.7	-12.0	-11.8	-11.9	-11.4	-11.0	-13.7	-13.3
POL VV	-11.9	-12.3	-11.4	-11.4	-10.1	-9.3	-9.3	-9.7	-8.8	-11.1	-10.2

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.5	-15.9	-14.9	-14.4	-14.0	-13.3	-13.6	-13.4	-12.9	-14.2	-14.3
POL VV	-13.8	-13.4	-13.0	-12.8	-12.2	-10.7	-11.4	-10.7	-11.3	-12.8	-11.4

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-18.5	-17.8	-16.9	-16.0	-15.5	-15.2	-15.7	-14.9	-14.4	-16.0	-15.9
POL VV	-16.6	-16.3	-15.3	-14.2	-13.9	-12.9	-13.0	-12.8	-13.4	-14.5	-13.1

Averaged Sigmao Soybeans, July 3, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-4.7	-6.0	-6.1	-8.6	-5.6	-5.4	-7.0	-5.3	-3.6	-5.8	-6.1
POL VV	-6.1	-6.7	-6.4	-7.9	-5.8	-2.9	-3.2	-0.2	-1.9	-3.6	-3.0

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.0	-11.5	-7.4	-6.8	-6.0	-7.0	-7.0	-6.4	-6.6	-8.3	-8.8
POL VV	-7.2	-9.8	-3.6	-4.9	-6.3	-6.5	-4.5	-5.3	-5.1	-6.6	-5.4

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.6	-9.6	-8.5	-8.5	-6.8	-8.2	-9.4	-6.4	-7.2	-9.8	-10.0
POL VV	-7.3	-9.2	-9.0	-7.9	-5.6	-7.6	-7.0	-6.5	-7.2	-8.2	-7.8

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.4	-11.5	-9.4	-9.4	-8.7	-8.8	-9.1	-7.1	-6.8	-9.1	-10.4
POL VV	-10.4	-9.7	-8.5	-8.9	-7.8	-6.6	-6.2	-5.6	-6.7	-8.4	-7.7

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.1	-12.5	-10.8	-10.3	-10.4	-8.8	-8.9	-8.3	-6.8	-9.7	-11.4
POL VV	-10.9	-10.5	-9.1	-8.6	-9.0	-6.9	-6.7	-6.2	-6.1	-8.5	-7.9

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.9	-11.7	-11.0	-11.2	-10.4	-10.3	-11.0	-10.5	-10.0	-12.0	-12.0
POL VV	-11.1	-12.1	-9.5	-10.2	-9.6	-8.2	-8.4	-8.2	-8.2	-9.9	-9.1

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.1	-13.8	-13.1	-13.6	-12.2	-11.5	-12.4	-11.4	-11.0	-13.0	-13.2
POL VV	-12.5	-12.9	-11.8	-11.8	-10.9	-9.7	-10.2	-9.7	-9.9	-11.1	-9.8

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-17.0	-16.6	-15.4	-14.9	-14.0	-13.4	-14.1	-13.5	-13.0	-14.6	-14.6
POL VV	-15.1	-14.5	-13.6	-13.1	-12.4	-11.8	-11.7	-11.0	-11.3	-13.1	-11.8

Averaged Sigmao Soybeans, July 9, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	2.6	1.6	6.9	6.4	5.4	4.2	3.4	3.9	5.0	2.6	1.3
POL VV	4.0	2.9	7.9	7.3	7.6	6.1	5.6	5.0	5.7	5.6	4.2

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.0	-8.6	-3.8	-3.9	-5.5	-2.7	-4.1	-4.7	-2.5	-5.8	-5.6
POL VV	-4.9	-8.1	-3.4	-4.5	-2.3	-1.6	-2.1	-3.9	-1.6	-5.4	-4.9

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.7	-8.7	-8.3	-5.9	-6.4	-5.5	-7.2	-6.4	-6.1	-7.0	-7.5
POL VV	-8.8	-7.9	-7.5	-5.6	-5.7	-4.2	-5.4	-4.8	-4.7	-6.0	-5.5

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.8	-10.5	-8.6	-8.7	-7.7	-7.6	-8.3	-7.9	-6.5	-7.5	-9.0
POL VV	-8.1	-9.0	-7.0	-7.7	-6.5	-6.5	-6.4	-5.2	-5.1	-6.7	-6.1

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.9	-11.6	-11.0	-10.0	-10.6	-8.6	-9.6	-8.6	-9.0	-8.9	-10.2
POL VV	-10.9	-10.3	-9.0	-9.0	-8.7	-7.2	-7.2	-7.1	-6.9	-8.1	-8.1

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.2	-12.9	-11.8	-11.9	-10.8	-10.5	-10.8	-9.8	-9.4	-10.4	-11.5
POL VV	-11.9	-11.7	-10.2	-10.0	-9.1	-8.0	-7.9	-7.5	-8.1	-9.5	-8.3

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.8	-14.0	-13.1	-13.3	-12.8	-11.8	-12.2	-11.7	-11.5	-12.1	-12.7
POL VV	-13.6	-13.9	-12.6	-11.6	-10.9	-10.2	-10.3	-9.5	-9.9	-10.9	-10.6

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-17.2	-16.6	-15.9	-15.1	-14.5	-14.2	-14.5	-14.0	-13.4	-14.8	-15.0
POL VV	-15.6	-15.2	-14.3	-13.9	-13.2	-12.2	-12.3	-11.3	-12.2	-13.0	-12.3

Averaged Sigmao Soybeans, July 15, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	4.7	4.0	5.3	3.8	4.2	4.6	3.3	3.9	2.3	1.5	1.5*
POL VV	6.6	6.3	7.0	5.5	5.9	5.0	4.1	3.5	2.2	0.6	0.6*

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-6.4	-7.1	-6.4	-5.5	-5.5	-4.1	-4.7	-4.0	-3.3	-4.6	-4.6*
POL VV	-4.7	-6.9	-6.6	-5.6	-4.4	-2.4	-3.1	-1.9	-3.3	-4.1	-4.1*

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.4	-7.8	-8.1	-6.6	-5.5	-6.3	-6.8	-6.2	-5.3	-6.3	-6.3*
POL VV	-6.7	-7.1	-7.4	-5.9	-5.0	-4.8	-5.3	-4.6	-4.3	-5.7	-5.7*

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.9	-10.0	-8.3	-8.6	-7.8	-6.9	-7.5	-7.5	-5.9	-7.1	-7.1*
POL VV	-8.5	-9.6	-8.0	-7.4	-5.7	-5.4	-5.4	-5.2	-4.8	-6.0	-6.0*

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.5	-10.6	-10.1	-10.0	-8.4	-8.3	-9.2	-8.3	-7.5	-8.3	-8.3*
POL VV	-9.4	-10.2	-8.4	-9.0	-8.0	-7.0	-7.0	-5.5	-5.7	-7.4	-7.4*

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.2	-12.3	-11.3	-11.3	-9.5	-9.2	-9.7	-9.7	-10.0	-10.0	-10.0*
POL VV	-10.8	-11.7	-9.7	-10.0	-8.0	-7.4	-7.8	-7.5	-8.1	-8.7	-8.7*

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.5	-14.5	-13.7	-12.5	-12.2	-11.3	-11.8	-11.3	-10.7	-12.4	-12.4*
POL VV	-12.8	-13.8	-12.7	-12.0	-10.4	-10.0	-10.2	-9.1	-9.6	-10.8	-10.8*

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.4	-16.2	-15.4	-14.4	-13.5	-13.5	-14.4	-11.6	-12.3	-13.8	-13.8*
POL VV	-14.8	-15.2	-14.1	-13.3	-12.0	-11.8	-11.4	-10.8	-11.6	-12.3	-12.3*

Averaged Sigmao Soybeans, July 19, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	0.	1.2	0.5	-0.5	1.6	3.4	3.3	4.3	5.9	2.3	2.3*
POL VV	1.6	0.3	0.7	0.5	2.8	3.0	4.0	5.1	4.2	2.6	2.6*

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.2	-6.4	-5.8	-2.4	-3.5	-5.0	-5.1	-4.6	-3.3	-5.0	-5.0*
POL VV	-6.6	-5.5	-4.6	-5.1	-3.4	-3.1	-3.2	-2.7	-2.9	-3.5	-3.5*

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.4	-8.1	-7.2	-6.5	-6.1	-4.8	-5.7	-6.1	-4.9	-5.9	-5.9*
POL VV	-7.7	-8.0	-5.9	-5.9	-4.6	-4.1	-4.0	-3.8	-4.5	-5.7	-5.7*

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.3	-9.1	-8.4	-7.5	-7.2	-6.0	-6.7	-7.2	-5.7	-6.9	-6.9*
POL VV	-9.0	-8.7	-7.5	-7.0	-5.5	-4.4	-5.1	-4.5	-5.3	-6.1	-6.1*

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.7	-10.1	-9.5	-8.7	-8.0	-7.9	-8.2	-7.0	-7.0	-8.3	-8.3*
POL VV	-9.7	-8.8	-9.0	-7.8	-7.0	-5.6	-5.8	-4.6	-4.5	-6.2	-6.2*

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.1	-11.5	-10.7	-10.2	-9.3	-8.8	-9.9	-8.9	-7.9	-9.2	-9.2*
POL VV	-11.2	-11.0	-9.5	-8.7	-7.9	-6.5	-6.5	-5.5	-6.4	-7.7	-7.7*

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.9	-13.9	-12.7	-12.0	-11.2	-10.7	-11.1	-10.4	-9.9	-11.2	-11.2*
POL VV	-12.4	-12.2	-11.2	-10.8	-9.5	-6.9	-7.0	-5.7	-6.8	-7.5	-7.5*

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.3	-15.8	-14.7	-14.0	-13.3	-12.8	-13.4	-12.2	-12.3	-13.0	-13.0*
POL VV	-14.6	-14.4	-13.6	-12.3	-11.7	-11.0	-11.0	-10.1	-10.3	-11.6	-11.6*

Averaged Sigmao Soybeans, July 24, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	3.8	2.4	5.0	3.7	4.6	4.3	4.1	3.4	5.5	1.9	2.2
POL VV	4.4	3.6	5.7	5.0	5.8	4.5	5.1	4.9	5.2	3.4	4.2

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.5	-7.7	-5.6	-4.5	-4.9	-5.9	-5.2	-4.1	-3.1	-5.3	-5.2
POL VV	-7.0	-7.3	-5.6	-4.9	-4.1	-4.6	-2.9	-2.6	-2.7	-5.1	-3.2

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.4	-8.6	-7.9	-7.2	-5.1	-7.0	-6.4	-6.3	-5.3	-6.3	-6.8
POL VV	-7.8	-8.3	-5.9	-6.7	-4.6	-5.8	-4.1	-3.8	-3.5	-5.3	-4.4

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.2	-9.9	-8.3	-8.6	-7.5	-7.8	-6.8	-7.0	-5.6	-7.8	-7.5
POL VV	-8.0	-8.8	-7.2	-7.5	-6.3	-6.6	-5.1	-5.3	-4.2	-5.7	-5.2

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.1	-10.9	-9.3	-9.1	-7.9	-8.7	-8.2	-8.2	-6.4	-8.0	-8.4
POL VV	-10.4	-9.4	-9.2	-8.1	-6.7	-7.3	-6.5	-6.6	-5.4	-7.2	-5.8

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.9	-10.9	-10.4	-10.1	-9.7	-10.3	-10.3	-9.8	-8.2	-9.6	-9.5
POL VV	-10.3	-11.1	-10.1	-9.9	-8.6	-9.2	-8.0	-7.7	-7.4	-8.8	-7.2

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.4	-12.6	-12.0	-11.6	-11.1	-11.9	-11.1	-11.0	-9.5	-11.4	-11.4
POL VV	-12.3	-12.3	-11.2	-10.8	-10.0	-10.6	-9.3	-8.7	-8.7	-10.0	-8.3

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.0	-15.8	-14.8	-14.0	-13.6	-14.1	-13.6	-13.2	-12.3	-13.5	-13.6
POL VV	-14.8	-14.9	-13.6	-12.9	-12.2	-12.9	-11.6	-11.4	-10.9	-12.0	-10.5

Averaged Sigmao Soybeans, July 26, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	4.7	2.2	2.0	1.0	2.6	2.4	4.7	6.3	7.8	6.3	5.0
POL VV	5.8	5.0	4.8	1.6	2.9	2.1	4.1	5.0	6.0	4.9	4.4

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.4	-6.9	-4.9	-5.8	-5.2	-3.8	-2.8	-4.7	-2.4	-4.2	-4.3
POL VV	-5.7	-6.6	-4.4	-4.6	-4.6	-4.5	-3.0	-2.8	-2.2	-4.0	-2.9

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.2	-7.7	-6.0	-6.5	-5.0	-5.9	-5.2	-5.5	-3.9	-5.7	-5.0
POL VV	-7.6	-7.4	-6.5	-5.3	-4.5	-5.1	-3.5	-3.7	-3.3	-4.5	-3.4

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.1	-9.2	-8.3	-7.7	-7.8	-7.0	-6.8	-6.8	-4.8	-6.4	-6.4
POL VV	-8.2	-8.1	-6.7	-6.3	-4.9	-6.1	-4.3	-4.3	-3.2	-5.0	-4.2

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.0	-10.6	-8.7	-8.5	-7.8	-7.7	-7.7	-7.4	-5.8	-7.3	-7.0
POL VV	-8.6	-9.1	-7.6	-7.5	-6.9	-6.4	-5.0	-5.4	-3.5	-5.6	-4.1

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.5	-11.7	-9.6	-9.4	-9.4	-9.6	-9.3	-8.3	-7.3	-8.4	-7.8
POL VV	-9.9	-10.2	-8.6	-8.4	-7.6	-7.5	-6.8	-6.7	-4.9	-6.7	-4.8

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.1	-13.2	-11.8	-10.9	-10.5	-11.3	-10.8	-10.8	-9.2	-10.7	-10.3
POL VV	-12.0	-12.3	-11.0	-9.8	-9.5	-9.5	-8.2	-8.4	-7.4	-8.5	-7.2

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.2	-15.1	-14.3	-13.1	-13.0	-13.1	-12.4	-12.2	-11.1	-12.1	-11.7
POL VV	-13.9	-14.2	-13.0	-12.0	-11.1	-11.5	-10.1	-9.9	-9.6	-10.3	-9.0

Averaged Sigmao Soybeans, August 2, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	0.4	-1.8	-0.8	-0.9	0.7	-0.7	-1.3	-0.8	0.1	-1.6	-1.3
POL VV	1.9	-0.8	0.	-0.4	-0.4	-1.1	-0.9	-0.8	-0.7	-1.7	-0.2

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.1	-5.6	-4.5	-4.7	-5.0	-5.2	-5.0	-4.7	-2.2	-5.5	-4.4
POL VV	-4.4	-4.7	-4.6	-4.7	-4.3	-4.5	-3.6	-3.0	-3.4	-4.5	-2.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.2	-7.5	-7.2	-6.7	-5.4	-6.9	-6.4	-5.8	-4.9	-6.1	-5.7
POL VV	-6.4	-6.9	-6.6	-5.7	-4.5	-5.2	-4.5	-4.1	-4.2	-5.5	-3.1

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.4	-8.8	-8.4	-7.7	-7.5	-8.3	-7.9	-6.9	-5.9	-7.8	-6.6
POL VV	-7.1	-7.6	-6.3	-6.8	-5.8	-6.2	-4.8	-4.4	-4.5	-6.2	-3.9

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.7	-9.9	-9.1	-8.8	-8.7	-8.6	-8.7	-7.9	-6.8	-8.4	-7.6
POL VV	-8.3	-8.9	-7.7	-7.7	-7.2	-7.3	-6.5	-5.9	-4.9	-7.1	-4.5

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.2	-11.6	-10.6	-10.3	-9.6	-10.3	-10.2	-9.5	-8.6	-10.3	-9.4
POL VV	-9.6	-10.5	-9.5	-9.3	-8.7	-9.0	-8.1	-7.0	-7.4	-8.7	-6.2

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.1	-13.3	-12.8	-12.2	-11.9	-12.2	-12.3	-11.4	-10.6	-12.1	-11.3
POL VV	-11.7	-12.3	-11.0	-10.7	-10.4	-10.8	-10.0	-9.0	-8.9	-10.4	-8.1

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.6	-15.4	-15.1	-14.7	-13.9	-14.4	-14.2	-13.6	-13	-14.5	-13.5
POL VV	-13.9	-14.2	-13.4	-13.1	-12.3	-12.6	-12.0	-11.3	-11.7	-12.7	-9.9

Averaged Sigmao Soybeans, August 6, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	1.0	0.3	1.7	0.1	-0.4	-0.7	1.1	1.2	2.7	-0.8	-1.3
POL VV	2.5	1.3	1.6	0.1	0.5	1.2	2.3	2.3	2.0	-1.3	-0.5

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-6.6	-7.0	-6.5	-6.4	-6.2	-6.8	-7.3	-5.7	-4.6	-6.9	-7.5
POL VV	-4.7	-6.4	-5.0	-4.7	-4.5	-6.1	-4.8	-5.1	-4.0	-6.0	-5.6

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.0	-8.1	-8.3	-7.5	-7.2	-7.9	-8.1	-6.7	-7.0	-8.0	-8.2
POL VV	-6.7	-7.3	-6.5	-7.0	-6.6	-6.3	-5.2	-5.0	-5.2	-6.1	-5.8

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.0	-10.0	-9.2	-8.6	-9.0	-9.6	-8.9	-8.9	-7.6	-9.6	-10.5
POL VV	-7.7	-8.4	-8.2	-8.1	-6.8	-7.7	-6.3	-6.4	-6.4	-7.4	-6.3

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.0	-11.0	-10.0	-10.4	-9.4	-10.5	-10.3	-10.8	-9.2	-11.2	-11.1
POL VV	-9.4	-9.2	-8.9	-9.2	-8.8	-8.8	-7.7	-7.5	-8.0	-9.2	-7.3

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.8	-13.6	-12.8	-12.4	-12.3	-12.6	-12.6	-12.6	-11.6	-13.3	-12.5
POL VV	-11.2	-11.2	-10.5	-10.6	-10.6	-10.8	-9.3	-9.6	-8.8	-10.8	-9.6

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.2	-15.4	-15.2	-14.6	-14.4	-15.2	-15.2	-14.9	-13.9	-15.3	-15.6
POL VV	-13.1	-13.8	-12.8	-12.7	-12.3	-13.5	-12.2	-12.1	-12.3	-13.3	-11.9

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-17.8	-18.3	-17.8	-18.0	-16.9	-18.1	-17.9	-17.4	-16.7	-18.1	-18.0
POL VV	-16.6	-16.5	-16.0	-15.8	-15.2	-15.7	-14.7	-14.7	-14.7	-16.0	-14.5

Averaged Sigmao Soybeans, August 9, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	2.0	-0.3	0.4	0.	0.9	-1.7	-0.7	-0.9	-0.8	-1.7	-3.5
POL VV	3.4	1.0	0.6	-0.1	0.	-2.0	-0.2	-1.5	-0.8	-2.5	-0.7

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.0	-8.3	-8.1	-7.9	-8.0	-6.6	-6.6	-6.8	-6.0	-7.6	-6.9
POL VV	-5.7	-6.1	-6.0	-5.5	-4.9	-4.9	-3.4	-3.4	-3.4	-5.7	-3.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.4	-8.9	-8.0	-7.8	-6.6	-7.8	-6.9	-6.4	-5.5	-8.3	-7.7
POL VV	-6.0	-7.5	-6.0	-5.6	-5.7	-5.9	-4.5	-3.8	-4.9	-5.9	-4.4

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.0	-10.4	-9.1	-8.8	-9.0	-8.4	-8.7	-7.7	-7.9	-9.0	-8.0
POL VV	-7.7	-8.5	-7.2	-7.0	-6.9	-6.2	-6.0	-5.5	-5.2	-6.5	-4.2

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.0	-11.7	-10.8	-10.4	-10.1	-10.5	-10.7	-9.6	-8.9	-10.6	-10.0
POL VV	-8.0	-10.1	-9.0	-9.2	-8.0	-8.2	-6.5	-6.5	-6.9	-8.5	-6.4

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.7	-14.0	-12.8	-12.7	-12.3	-12.7	-12.7	-12.5	-11.7	-13.0	-12.7
POL VV	-10.6	-11.9	-11.0	-10.8	-10.5	-11.0	-9.9	-9.2	-9.6	-10.3	-8.7

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.1	-15.5	-15.4	-15.1	-15.0	-15.5	-15.3	-15.2	-14.2	-15.3	-15.1
POL VV	-12.2	-13.5	-12.4	-12.4	-11.9	-13.2	-11.7	-11.2	-10.9	-12.6	-10.9

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-18.2	-18.8	-18.6	-17.8	-17.5	-17.9	-18.2	-17.2	-16.6	-18.0	-16.5
POL VV	-15.6	-16.4	-16.3	-16.4	-15.3	-15.6	-14.3	-14.4	-14.5	-15.8	-13.9

Averaged Sigmao Soybeans, August 20,1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-1.6	-3.1	-2.9	-1.7	-2.0	-2.6	-2.9	-2.1	-0.3	-1.8	-2.3
POL VV	-0.3	-2.2	-0.9	-0.1	0.5	-0.4	1.3	1.2	1.3	-0.3	0.4

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.5	-6.4	-5.6	-5.4	-5.0	-5.7	-5.6	-4.9	-4.2	-5.9	-5.7
POL VV	-4.5	-5.3	-4.1	-4.1	-3.4	-4.1	-3.3	-2.4	-2.6	-4.0	-2.9

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.3	-7.9	-7.2	-6.6	-6.4	-6.2	-6.2	-4.9	-4.3	-5.8	-5.8
POL VV	-5.8	-6.2	-5.6	-5.0	-4.1	-4.5	-3.2	-3.1	-2.9	-3.9	-3.2

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.3	-8.8	-8.0	-7.4	-7.1	-7.5	-7.0	-6.7	-5.7	-7.6	-7.3
POL VV	-6.2	-6.9	-6.0	-6.1	-5.6	-5.6	-4.6	-4.3	-3.7	-5.3	-3.9

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.8	-10.0	-9.6	-9.0	-8.5	-8.7	-8.7	-8.2	-7.0	-8.5	-8.6
POL VV	-7.1	-7.7	-7.4	-7.1	-6.4	-6.6	-5.4	-5.2	-4.7	-6.5	-5.2

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.2	-11.4	-10.6	-10.1	-9.8	-10.3	-10.2	-9.5	-8.4	-10.0	-9.8
POL VV	-8.2	-9.0	-8.2	-8.1	-7.6	-7.7	-6.2	-6.2	-5.8	-7.4	-6.2

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.4	-12.7	-12.0	-11.8	-11.3	-11.6	-11.5	-10.7	-10.0	-11.2	-11.2
POL VV	-8.7	-9.6	-9.1	-8.7	-8.2	-9.0	-8.0	-7.7	-7.4	-8.6	-7.4

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.0	-15.2	-14.6	-13.6	-13.5	-13.9	-13.7	-12.9	-12.3	-13.2	-13.3
POL VV	-10.7	-11.6	-10.9	-10.9	-10.4	-11.0	-9.8	-9.8	-9.7	-10.9	-9.5

Averaged Sigmao Soybeans, August 22, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-3.3	-4.3	-3.0	-3.2	-3.2	-4.0	-3.3	-3.4	-2.5	-4.1	-4.4
POL VV	-1.9	-3.3	-2.2	-2.0	-1.9	-2.8	-2.0	-1.7	-1.4	-2.5	-2.2

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.6	-6.0	-5.8	-6.0	-5.3	-5.8	-4.7	-5.0	-2.9	-5.3	-4.8
POL VV	-4.5	-5.4	-4.3	-4.9	-3.8	-4.7	-3.8	-3.8	-2.8	-4.8	-4.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.0	-7.8	-7.5	-6.1	-7.1	-6.7	-6.3	-6.1	-5.4	-6.5	-7.7
POL VV	-6.3	-6.4	-6.0	-5.6	-5.5	-5.1	-3.9	-4.0	-4.4	-5.4	-4.9

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.5	-10.0	-8.5	-7.5	-8.6	-9.2	-8.5	-8.0	-6.7	-8.1	-8.5
POL VV	-7.1	-8.2	-6.6	-6.8	-6.5	-6.3	-5.3	-5.1	-5.1	-6.9	-5.4

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.8	-11.5	-10.6	-9.7	-10.1	-10.5	-9.8	-8.7	-7.5	-9.7	-10.0
POL VV	-8.9	-9.2	-8.1	-9.0	-7.1	-8.4	-6.5	-6.2	-6.1	-8.0	-7.1

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.4	-12.9	-12.3	-11.6	-11.1	-11.9	-11.8	-12.0	-10.6	-12.2	-12.1
POL VV	-10.8	-11.1	-10.3	-10.3	-9.4	-10.0	-9.9	-9.8	-8.4	-9.7	-8.5

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.1	-15.8	-14.6	-14.0	-13.5	-13.8	-14.1	-13.5	-12.6	-14.1	-13.8
POL VV	-11.9	-12.9	-12.3	-11.8	-11.5	-12.4	-11.3	-10.8	-10.5	-11.9	-10.6

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-17.3	-17.2	-17.1	-16.0	-16.2	-15.4	-16.1	-15.4	-14.7	-15.5	-15.3
POL VV	-13.3	-14.2	-13.8	-13.6	-13.9	-13.5	-13.1	-12.6	-12.6	-13.9	-12.1

APPENDIX D: Milo Scattering Coefficients, 1974.

Averaged Sigmao Milo, July 12, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.9	-9.0	-6.1	-6.9	-6.8	-4.7	-4.1	-4.1	-4.0	-6.2	-7.7
POL VV	-7.4	-8.5	-6.9	-8.2	-6.9	-2.6	-4.9	-4.2	-4.5	-4.5	-4.5

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.5	-11.3	-8.4	-7.9	-7.7	-7.3	-5.8	-5.1	-5.7	-7.3	-7.6
POL VV	-8.5	-8.6	-9.2	-8.5	-4.5	-2.0	-3.4	-2.4	-4.7	-7.0	-5.9

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.9	-10.3	-8.9	-9.1	-6.7	-6.5	-7.4	-7.4	-4.5	-7.2	-9.0
POL VV	-9.6	-9.1	-6.9	-5.1	-5.7	-6.0	-4.6	-5.2	-3.4	-6.8	-6.6

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.7	-11.8	-9.4	-11.1	-9.8	-8.7	-8.4	-7.8	-7.5	-8.3	-9.2
POL VV	-9.4	-10.4	-7.5	-8.7	-8.4	-6.0	-5.7	-6.2	-5.5	-6.5	-5.6

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.1	-11.4	-11.8	-9.4	-9.1	-8.4	-9.4	-9.0	-8.1	-8.8	-7.8
POL VV	-11.3	-10.3	-8.6	-9.0	-7.1	-6.4	-6.2	-6.1	-6.4	-7.2	-6.7

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.9	-12.2	-10.4	-11.0	-11.0	-9.2	-9.8	-9.3	-8.8	-9.0	-11.0
POL VV	-11.3	-11.7	-9.2	-9.5	-8.4	-7.4	-7.4	-7.1	-7.1	-7.5	-6.7

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.2	-13.9	-13.5	-12.0	-11.5	-10.9	-11.2	-10.6	-10.2	-11.0	-11.5
POL VV	-12.2	-12.9	-11.0	-10.5	-9.4	-8.4	-8.6	-7.9	-8.4	-9.5	-8.3

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.5	-15.7	-15.0	-14.3	-13.9	-13.1	-14.0	-12.9	-12.6	-13.5	-14.1
POL VV	-14.7	-14.3	-13.4	-12.6	-12.0	-11.2	-11.2	-10.0	-10.7	-11.6	-11.2

Averaged Sigmao Milo, July 18, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.8	-9.1	-7.5	-6.5	-7.0	-4.5	-5.0	-5.8	-3.9	-5.3	-5.3
POL VV	-6.6	-8.2	-7.5	-7.7	-4.7	-5.2	-2.9	-3.7	-4.1	-5.1	-5.1

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.3	-9.3	-8.0	-8.0	-7.8	-6.2	-7.1	-6.6	-5.6	-7.4	-7.4
POL VV	-8.1	-8.4	-5.6	-8.0	-6.6	-5.0	-5.0	-4.2	-5.7	-6.4	-6.4

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.8	-10.0	-9.3	-8.8	-8.1	-8.5	-7.8	-7.2	-6.7	-7.1	-7.1
POL VV	-9.2	-9.6	-8.7	-7.7	-6.5	-6.2	-5.3	-5.0	-4.9	-6.2	-6.2

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.7	-10.7	-8.6	-9.7	-9.3	-7.7	-8.2	-7.0	-6.6	-7.7	-7.7
POL VV	-8.3	-9.3	-7.6	-8.0	-7.3	-6.2	-5.7	-4.8	-5.3	-6.8	-6.8

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.6	-11.7	-9.9	-10.1	-9.5	-9.1	-9.4	-8.2	-6.9	-8.1	-8.1
POL VV	-9.4	-9.5	-8.2	-8.5	-7.8	-7.6	-5.6	-5.1	-5.3	-7.2	-7.2

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.4	-11.7	-11.4	-10.9	-10.3	-10.1	-10.4	-8.4	-8.1	-9.8	-9.8
POL VV	-10.1	-10.8	-9.1	-10.1	-8.7	-8.4	-7.3	-6.0	-6.0	-8.6	-8.6

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.5	-12.5	-11.8	-11.5	-11.3	-10.8	-10.8	-9.5	-9.3	-10.3	-10.3
POL VV	-11.1	-11.2	-10.2	-10.3	-9.3	-8.9	-7.9	-7.1	-7.5	-8.2	-8.2

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.9	-14.6	-14.0	-13.2	-13.2	-12.8	-12.8	-11.9	-11.0	-12.4	-12.4
POL VV	-13.8	-13.5	-12.7	-12.2	-11.6	-10.9	-10.1	-9.3	-9.4	-10.7	-10.7

Averaged Sigmao Milo, July 25, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.6	-10.9	-8.6	-7.9	-7.2	-8.6	-6.0	-7.0	-6.0	-7.4	-5.7
POL VV	-8.7	-8.8	-6.8	-7.2	-7.0	-7.2	-6.6	-6.0	-3.9	-4.8	-5.1

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.7	-10.7	-9.0	-8.5	-7.5	-9.2	-8.8	-7.0	-5.7	-7.5	-7.5
POL VV	-8.7	-9.0	-7.6	-7.2	-6.1	-6.8	-6.5	-4.2	-6.5	-6.9	-5.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.4	-10.4	-9.8	-9.6	-7.6	-9.0	-8.4	-7.3	-7.3	-8.7	-8.0
POL VV	-8.1	-8.9	-7.9	-8.4	-6.4	-7.4	-6.2	-5.8	-5.1	-6.8	-4.0

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.7	-12.0	-11.0	-10.7	-9.2	-10.4	-9.4	-9.7	-7.1	-9.4	-8.8
POL VV	-10.0	-10.8	-7.8	-9.1	-7.8	-8.6	-7.5	-6.9	-4.6	-7.6	-5.4

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.9	-12.2	-11.3	-10.4	-9.3	-10.4	-9.7	-9.2	-8.3	-10.2	-9.1
POL VV	-10.4	-10.9	-9.3	-8.9	-8.5	-9.0	-7.5	-7.2	-6.3	-8.3	-5.5

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.3	-12.6	-11.5	-11.3	-11.4	-11.8	-11.6	-10.9	-10.3	-11.3	-10.2
POL VV	-11.0	-12.0	-10.1	-11.1	-8.9	-8.5	-8.1	-8.3	-6.9	-8.3	-7.0

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.1	-14.1	-13.3	-12.7	-12.0	-13.0	-12.8	-12.2	-10.6	-12.4	-11.3
POL VV	-13.0	-13.0	-12.0	-11.3	-11.0	-10.8	-10.2	-9.4	-8.9	-10.4	-8.3

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.2	-16.2	-14.8	-14.3	-13.8	-13.9	-14.2	-13.7	-12.7	-13.8	-13.2
POL VV	-14.6	-14.9	-14.1	-13.1	-12.4	-12.7	-11.8	-11.2	-11.8	-12.1	-10.6

Averaged Sigmao Milo, August 1, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.8	-8.6	-7.4	-7.3	-7.5	-8.9	-8.0	-8.3	-5.9	-7.8	-7.8
POL VV	-8.0	-7.0	-7.3	-7.2	-5.6	-6.5	-5.4	-5.7	-6.7	-8.1	-7.6

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.9	-9.1	-7.9	-8.5	-8.7	-8.9	-7.7	-8.2	-6.3	-8.4	-8.4
POL VV	-9.3	-9.1	-8.6	-7.6	-7.1	-7.2	-6.4	-6.0	-5.3	-7.8	-6.8

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.7	-10.1	-9.7	-8.8	-9.1	-8.1	-7.6	-7.4	-6.6	-8.2	-8.2
POL VV	-7.7	-8.6	-8.2	-8.0	-6.9	-6.4	-5.3	-5.8	-6.1	-6.8	-6.4

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.7	-10.8	-9.6	-8.8	-8.5	-8.2	-7.7	-8.3	-6.8	-8.5	-8.7
POL VV	-8.7	-8.7	-8.1	-7.3	-6.9	-8.3	-5.9	-6.8	-5.1	-7.0	-5.7

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.1	-10.5	-9.5	-9.4	-8.8	-9.2	-8.5	-8.2	-7.2	-9.2	-8.5
POL VV	-8.9	-9.2	-8.2	-7.5	-7.3	-7.5	-6.4	-6.0	-4.6	-6.5	-5.2

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.2	-11.6	-11.6	-10.5	-10.2	-10.7	-10.1	-9.8	-9.2	-10.1	-10.5
POL VV	-10.6	-10.9	-9.5	-9.5	-8.6	-9.6	-7.8	-7.2	-6.8	-8.0	-7.4

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.5	-12.4	-11.9	-11.4	-11.1	-11.5	-11.5	-10.8	-10.1	-11.0	-11.2
POL VV	-11.8	-12.0	-10.8	-10.8	-9.8	-10.5	-8.4	-8.3	-8.3	-9.6	-8.1

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.2	-14.3	-13.8	-13.0	-12.7	-13.3	-13.2	-12.7	-12.1	-13.0	-13.1
POL VV	-13.4	-13.9	-12.8	-12.4	-11.6	-11.7	-10.5	-10.0	-10.1	-11.3	-9.9

Averaged Sigmao Milo, August 7, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-3.4	-4.3	-5.0	-5.2	-5.6	-5.0	-5.5	-5.2	-2.8	-5.2	-6.2
POL VV	-1.6	-2.5	-4.8	-3.8	-2.7	-3.1	-3.8	-2.4	-1.5	-4.6	-3.5

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.1	-8.5	-6.2	-5.6	-5.9	-6.0	-5.7	-5.3	-4.6	-7.0	-6.6
POL VV	-5.8	-6.7	-5.1	-4.8	-5.5	-5.1	-4.6	-3.7	-3.2	-5.4	-3.9

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.8	-8.2	-7.0	-7.4	-6.7	-7.0	-6.6	-6.3	-4.8	-8.2	-7.0
POL VV	-5.7	-7.6	-5.9	-6.0	-5.3	-5.4	-4.3	-4.0	-3.8	-4.6	-4.0

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.4	-9.7	-9.0	-7.6	-7.5	-8.7	-7.7	-7.1	-6.4	-7.2	-8.8
POL VV	-7.3	-8.9	-6.9	-6.5	-6.8	-7.3	-5.4	-5.1	-5.1	-6.9	-5.3

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.2	-10.5	-9.5	-9.7	-9.5	-9.2	-8.6	-8.9	-7.5	-8.8	-9.0
POL VV	-8.9	-9.1	-8.8	-7.3	-7.0	-7.5	-5.4	-6.1	-4.4	-6.2	-5.6

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.0	-11.0	-11.2	-9.9	-9.7	-10.7	-9.5	-9.2	-8.0	-9.7	-10.1
POL VV	-8.8	-10.2	-9.6	-9.0	-8.1	-8.6	-6.8	-7.5	-5.9	-7.6	-6.1

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.9	-12.7	-12.2	-11.8	-12.9	-12.6	-12.3	-11.6	-10.5	-12.1	-12.6
POL VV	-10.5	-11.5	-10.9	-10.9	-9.9	-10.3	-9.1	-8.4	-8.1	-9.5	-8.6

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.0	-15.3	-14.5	-14.2	-13.1	-14.3	-14.5	-13.5	-12.8	-14.6	-14.4
POL VV	-13.8	-14.2	-13.6	-13.7	-12.5	-13.4	-12.0	-11.5	-11.2	-12.1	-11.0

Averaged Sigmao Milo, August 19, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-6.8	-7.3	-6.1	-6.6	-6.9	-6.0	-5.9	-6.1	-4.0	-5.3	-5.5
POL VV	-4.9	-5.7	-5.9	-5.8	-5.4	-4.7	-3.9	-3.7	-2.5	-3.3	-2.8

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.3	-8.9	-6.7	-6.4	-6.9	-6.9	-6.8	-5.9	-5.4	-7.2	-7.5
POL VV	-5.6	-8.0	-6.5	-6.1	-5.7	-6.3	-3.9	-4.8	-5.4	-6.7	-5.3

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.3	-8.6	-8.0	-7.7	-7.1	-7.1	-7.5	-7.4	-5.1	-7.1	-7.9
POL VV	-6.7	-7.5	-6.1	-6.0	-6.5	-5.3	-5.0	-4.9	-3.8	-5.5	-5.1

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.5	-10.4	-10.1	-9.7	-9.8	-9.3	-9.5	-9.3	-7.3	-9.3	-9.7
POL VV	-8.7	-9.9	-8.5	-8.5	-7.7	-7.5	-6.9	-6.3	-6.6	-8.1	-6.5

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.5	-10.9	-10.4	-9.7	-9.6	-10.3	-9.5	-9.2	-8.7	-9.5	-10.2
POL VV	-10.0	-9.6	-8.8	-7.8	-7.6	-7.5	-6.4	-6.6	-6.2	-7.6	-6.1

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.6	-12.0	-11.2	-11.4	-10.6	-11.5	-11.4	-10.7	-10.3	-11.3	-11.4
POL VV	-11.2	-11.1	-10.6	-10.2	-9.0	-9.6	-8.8	-8.5	-8.4	-9.3	-8.5

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.2	-14.6	-13.2	-12.8	-12.9	-13.7	-13.5	-12.8	-12.4	-13.4	-13.4
POL VV	-12.4	-12.6	-11.9	-11.8	-10.7	-11.2	-9.9	-9.9	-10.0	-10.7	-10.0

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-16.0	-16.5	-16.0	-15.2	-15.1	-15.1	-14.9	-14.8	-14.2	-15.1	-15.2
POL VV	-14.4	-14.8	-14.0	-13.5	-12.7	-13.2	-12.2	-12.3	-11.8	-13.2	-11.6

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-6.0	-7.4	-6.0	-5.3	-4.4	-5.6	-4.6	-3.5	-2.0	-3.2	-3.7
POL VV	-5.7	-7.2	-6.2	-6.0	-4.5	-5.3	-3.7	-3.8	-2.8	-3.1	-3.7

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.7	-8.3	-8.4	-7.1	-6.8	-7.3	-6.7	-5.9	-5.4	-6.0	-6.6
POL VV	-5.7	-7.7	-6.0	-5.6	-5.2	-5.3	-4.0	-2.9	-2.8	-4.7	-3.5

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.6	-6.8	-7.1	-6.0	-6.3	-5.2	-5.7	-5.5	-3.8	-4.9	-5.4
POL VV	-5.8	-6.6	-4.2	-4.9	-3.7	-3.2	-1.9	-3.0	-1.8	-3.5	-2.6

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.8	-9.4	-8.0	-7.1	-7.3	-6.7	-7.5	-6.0	-4.9	-6.4	-6.4
POL VV	-7.0	-7.9	-5.7	-6.4	-5.8	-5.8	-4.5	-4.3	-4.0	-5.5	-3.9

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.9	-10.0	-9.5	-9.0	-8.6	-8.2	-7.7	-7.7	-6.7	-7.6	-7.5
POL VV	-8.1	-9.0	-7.4	-7.2	-6.7	-6.3	-5.0	-4.6	-4.4	-5.6	-4.9

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.9	-10.9	-9.8	-9.2	-9.0	-9.1	-9.0	-8.1	-7.3	-8.9	-9.1
POL VV	-9.2	-9.4	-8.3	-8.0	-7.7	-7.6	-6.0	-6.3	-5.4	-7.2	-5.5

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-12.9	-12.9	-11.9	-11.9	-11.3	-11.6	-11.6	-10.7	-9.5	-11.4	-11.0
POL VV	-10.9	-11.1	-10.5	-9.8	-9.6	-9.5	-8.4	-7.4	-7.5	-9.0	-7.5

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.7	-14.9	-14.2	-13.7	-13.6	-13.6	-13.4	-12.7	-12.1	-13.6	-13.2
POL VV	-13.2	-13.8	-12.8	-12.4	-11.5	-11.4	-10.5	-9.9	-10.0	-11.1	-9.8

Averaged Sigmao Milo, August 29, 1974

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	1.0	-0.2	2.0	2.9	3.7	3.0	2.6	2.2	2.4	-0.4	-0.6
POL VV	2.3	1.5	4.1	4.3	4.2	3.5	5.0	4.4	4.9	1.8	3.1

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-4.9	-4.9	-4.8	-2.3	-2.9	-3.2	-1.3	-1.5	-3.0	-4.7	-5.0
POL VV	-3.7	-4.3	-3.3	-2.9	-3.5	-3.5	-1.5	-1.6	-1.1	-3.3	-2.5

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-6.3	-7.4	-6.2	-6.2	-6.1	-6.5	-6.1	-5.9	-4.9	-6.6	-6.0
POL VV	-5.1	-6.8	-5.3	-4.8	-4.4	-4.8	-2.5	-3.4	-1.8	-4.2	-3.1

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-8.9	-8.6	-7.3	-6.8	-7.0	-7.7	-7.1	-7.3	-4.7	-7.4	-7.1
POL VV	-6.7	-7.1	-6.5	-4.9	-5.3	-5.7	-4.4	-3.9	-3.5	-5.5	-4.4

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.5	-9.1	-8.5	-8.6	-8.7	-9.0	-8.1	-7.4	-7.2	-8.3	-8.2
POL VV	-7.5	-8.2	-6.2	-7.3	-6.8	-6.2	-4.8	-4.7	-4.6	-5.6	-4.8

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-10.1	-10.5	-10.0	-9.2	-10.5	-9.8	-9.2	-8.9	-7.4	-9.6	-10.6
POL VV	-9.4	-8.9	-7.3	-8.3	-7.7	-7.2	-5.8	-6.1	-4.7	-7.1	-5.9

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-13.2	-13.9	-13.4	-12.7	-12.8	-12.8	-12.2	-12.1	-11.3	-12.7	-13.2
POL VV	-11.8	-11.8	-11.0	-10.8	-9.8	-10.3	-8.9	-8.6	-8.4	-9.5	-8.9

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.6	-16.1	-15.4	-15.5	-15.4	-15.7	-15.5	-15.0	-14.2	-15.6	-15.6
POL VV	-13.9	-14.7	-13.7	-13.9	-13.1	-13.5	-12.2	-12.7	-11.7	-13.6	-12.1

ANTENNA ANGLE 0

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.8	-4.9	-3.0	-2.2	-3.7	-4.6	-4.0	-3.7	-0.9	-4.4	-4.9
POL VV	-2.9	-4.3	-3.1	-3.7	-3.1	-4.6	-3.0	-2.6	-2.3	-4.1	-3.8

ANTENNA ANGLE 10

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-5.4	-6.1	-5.1	-3.7	-4.0	-5.3	-4.8	-4.7	-2.4	-4.3	-5.5
POL VV	-3.8	-5.2	-4.0	-3.4	-2.9	-2.8	-2.0	-3.0	-2.2	-3.9	-3.2

ANTENNA ANGLE 20

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.0	-9.3	-7.0	-7.1	-6.2	-6.9	-5.4	-6.2	-4.3	-6.5	-6.9
POL VV	-6.8	-8.5	-6.2	-6.1	-5.0	-5.7	-4.4	-3.3	-2.9	-5.2	-4.4

ANTENNA ANGLE 30

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-7.4	-8.9	-8.2	-8.8	-7.5	-8.9	-7.7	-7.8	-5.5	-8.2	-8.8
POL VV	-7.7	-8.4	-6.7	-6.8	-5.9	-6.4	-5.3	-5.3	-4.4	-5.9	-5.6

ANTENNA ANGLE 40

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-9.8	-11.5	-9.7	-9.2	-9.1	-10.8	-9.1	-9.2	-7.6	-9.4	-8.9
POL VV	-9.1	-10.1	-8.1	-8.3	-7.3	-8.7	-6.6	-6.0	-5.7	-8.9	-6.6

ANTENNA ANGLE 50

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-11.6	-11.7	-11.3	-11.0	-10.2	-10.5	-11.0	-10.5	-9.4	-11.2	-10.7
POL VV	-11.1	-11.3	-9.7	-9.4	-8.3	-9.3	-8.0	-7.5	-7.5	-8.9	-8.8

ANTENNA ANGLE 60

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-14.2	-14.0	-14.1	-13.3	-13.1	-13.9	-13.4	-12.4	-11.7	-13.6	-13.2
POL VV	-12.9	-13.9	-12.8	-12.0	-12.1	-11.9	-10.3	-10.7	-10.1	-11.8	-10.3

ANTENNA ANGLE 70

FREQ	8.6	9.4	10.2	11.0	11.8	13.0	13.8	14.6	15.4	16.2	17.0
POL HH	-15.6	-15.9	-15.9	-15.3	-15.8	-16.3	-15.1	-14.8	-14.8	-16.5	-15.9
POL VV	-14.4	-15.3	-14.2	-13.9	-14.0	-14.4	-12.8	-12.7	-12.6	-14.3	-13.3